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INDEX 68 BULLETIN L. D. 110A

# LIGHTING DATA

## EDISON LAMP WORKS
OF GENERAL ELECTRIC COMPANY

GENERAL SALES OFFICE HARRISON, N. J.

# The Lighting of Textile Mills

*Information Compiled by*
A. L. POWELL
*Lighting Service Department*

INDEX 68 JANUARY, 1923 BULLETIN L. D. 110A

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For information regarding MAZDA lamps and lighting questions, refer to the nearest sales office as listed on the last page.

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# *The Lighting of Textile Mills*

*Information Compiled by A. L. Powell*
*Lighting Service Department*

## *Introductory*

If one had followed closely the practice in textile mill illumination he would have a fairly comprehensive record of the development of modern lighting. In the early days, such incandescent lamps as were available were relatively inefficient and it was not economically feasible to light the entire space to an intensity which was recognized as desirable. As a result, so-called "local" or "drop" lighting was installed. Comparatively low candle-power lamps with rather ineffective shades were placed close to the working point, illuminating a small area to a reasonably high intensity. The operator often spent part of his time adjusting this lamp to suit his fancy and moving it from place to place. This procedure did not tend to make him efficient.

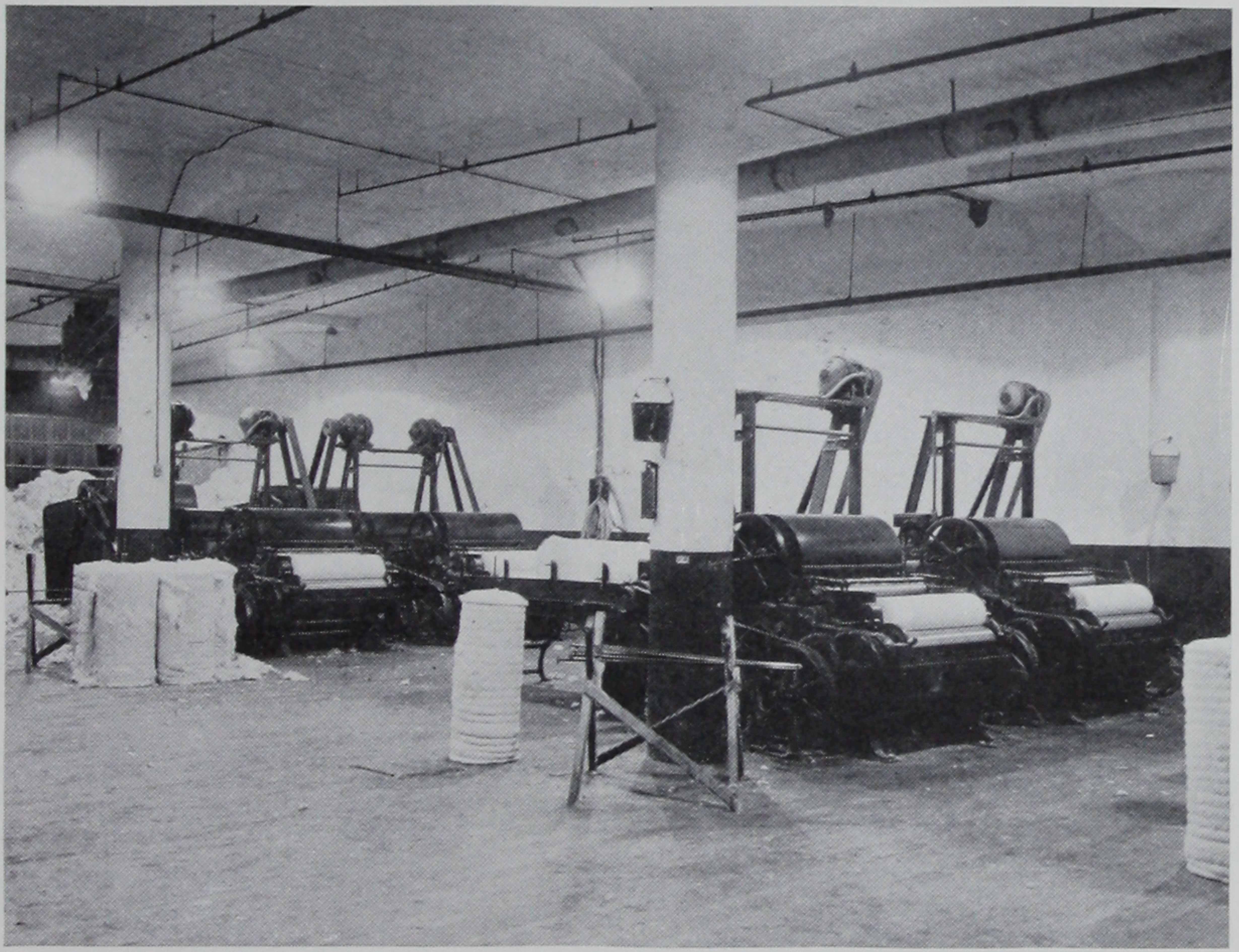

FIG. 1
Night View Pickers in a Cotton Mill Lighted by 200-watt Bowl Enameled MAZDA C Lamps in RLM Standard Dome Reflectors 13 Feet from the Floor on Centers 12 by 22 Feet. An approximately uniform intensity of four and one-half foot-candles is obtained throughout the room. The white surroundings assist materially in diffusing the light

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About fifteen years ago, the Mazda lamp appeared on the market and so-called group or localized general lighting came into use. With this system, medium size lamps equipped with fairly efficient reflectors were placed relative to the working point some eight or nine feet above the floor. This lighting was very much superior to that previously employed and the scheme of group or localized general layouts, as they are sometimes called, still has advantages for certain processes.

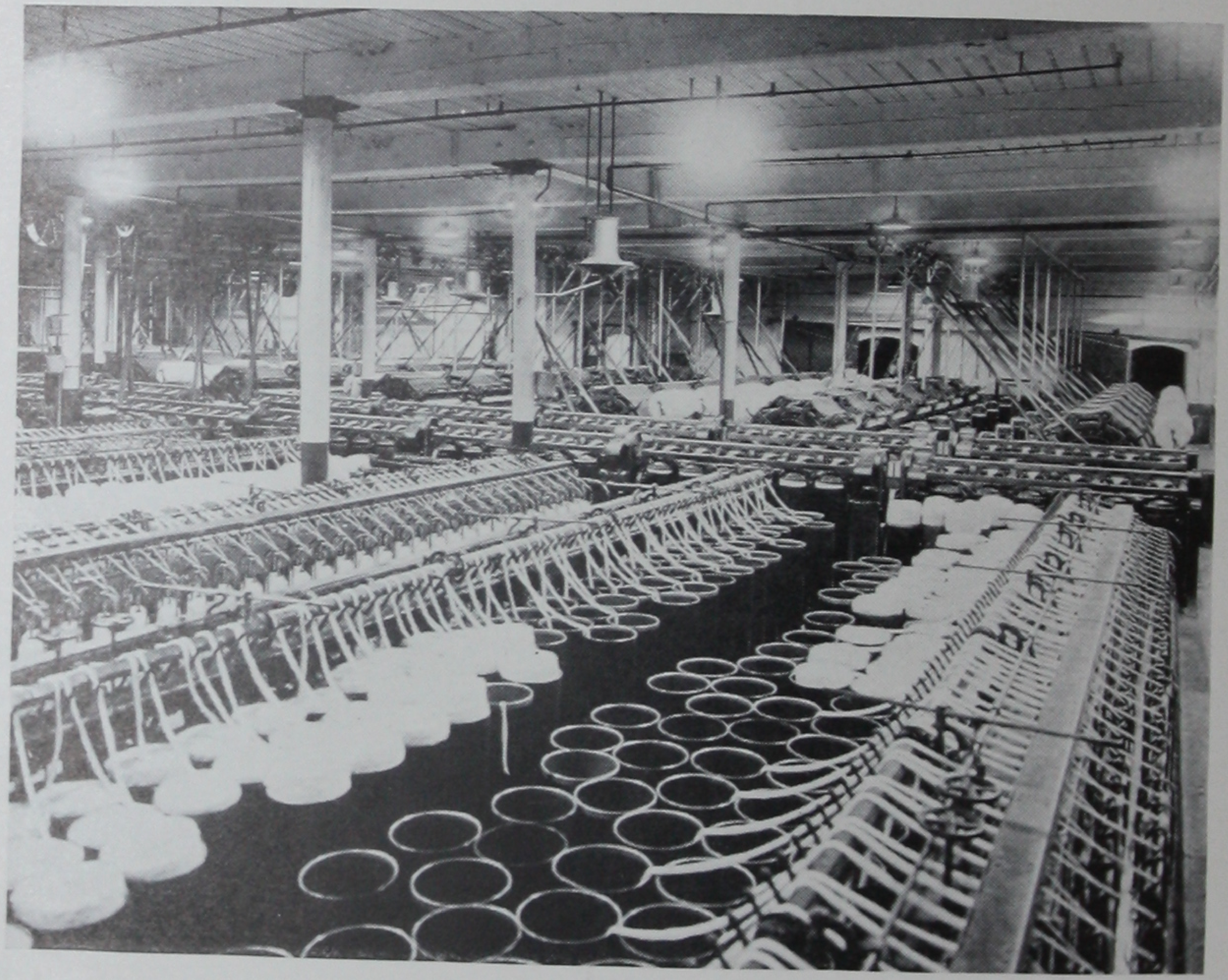

Fig. 2

Night View Slubbers, Drawing Frames and Cards Lighted by 200-watt Bowl Enameled Mazda C Lamps in RLM Standard Dome Reflectors on Centers 10 by 25 Feet. With the intensity of light produced, approximately seven foot-candles, safe and efficient operation of the machinery is assured

Slightly less than ten years ago, the Mazda C (gas-filled tungsten filament) lamp became available. This was appreciably more efficient than the Mazda B lamp and with its application came modifications in the lighting scheme. Lamps were hung higher than heretofore and located symmetrically with regard to the bays rather than with respect to the machine; in other words, strictly general illumination was applied.

The introduction of this system was hastened and made more feasible by the improvement in mill construction. In the more modern mills, higher ceilings are the rule. Overhead obstructions are much less, for group or individual machine drive has replaced line shafting and belting. The value of light-colored surroundings has been more generally recognized so that even indirect lighting can be successfully applied.

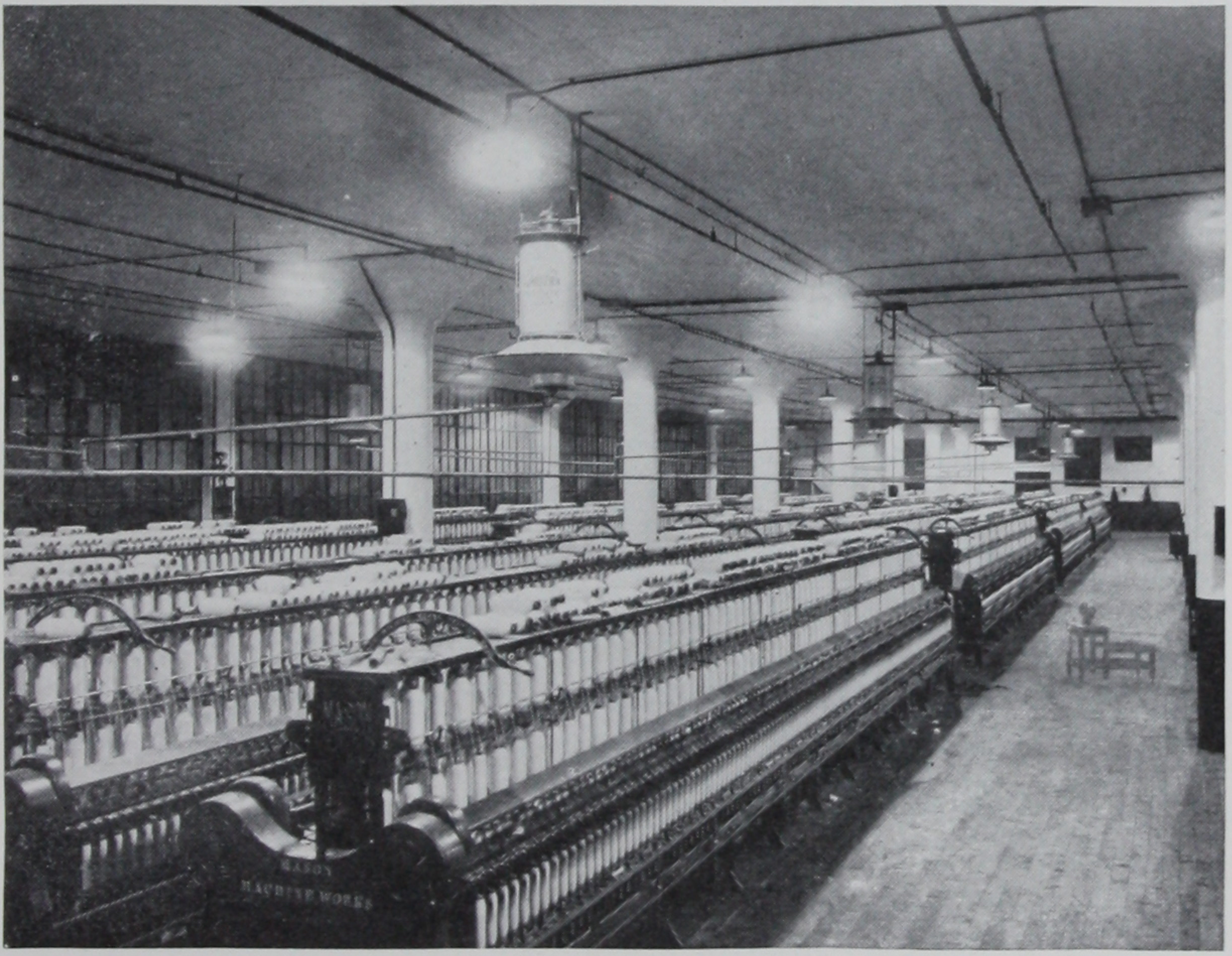

FIG. 3
A Spinning Room as it Appears by Night, Illuminated by 200-watt Bowl Enameled MAZDA C Lamps in RLM Standard Dome Reflectors 13 Feet Above the Floor. Two outlets are used in each bay of 22 by 25 feet in a staggered arrangement. The absence of overhead obstructions makes general lighting particularly feasible

It is interesting to contrast the appearance of a mill with the old style drop lamps supplying a few spots of high intensity with intervening areas in comparative darkness to the mill with general lighting which approaches daylight in character and uniformity. General lighting requires fewer outlets with decreased cost of wiring; renewal costs are lower, for lamps are out of reach and not so likely to become broken. The larger lamps used with this system are more efficient than the smaller sizes, in other words, they emit more light per unit of energy or watt consumed. The reflecting equipment has a longer life, and it is not soiled through constant handling.

The scheme of lighting in which we are interested makes a room far more cheerful and business like. Cheerful working conditions are essential if the morale of the employees is to be kept at a high order. If there are no dark corners in which refuse is permitted to accumulate, the plant will be more sanitary. Accidents are less frequent with high level general illumination. This is a very important factor and the reader is urged to study Bulletin Index 18, entitled "Light and Safety." Suitable light is as essential to the "safety first" movement as any of the guards which are applied to belts, pulleys and gears.

As lamps became more efficient, higher intensities of light were supplied and it was soon noted that there was a relation between lighting and production. A number of carefully conducted tests where records were kept of the production under old style lighting and under high level illumination have proven that increases in the order of ten per cent in production are possible through improving this one element of the plant. Certainly this is a factor which no progressive mill superintendent can afford to overlook. It is necessary for him to analyze every detail of operation in order that he may meet competition by turning out his product at the least possible manufacturing cost. The data presented in Bulletin Index 17, "Light and Production," will be, therefore, of vital interest.

Fortunately, the attitude toward lighting has gradually changed. It is no longer viewed as a necessary expense which must be minimized, but rather an important aid in the economic production of cloth.

## *Reflecting Equipment*

It is obvious that to obtain effective illumination, lamps must be equipped with suitable reflectors to protect the eye from the bright filament and to direct the light on the work. It is also necessary to diffuse the direct light from the lamp and thus soften shadows. With open reflectors, therefore, the so-called Bowl Enameled lamp is employed. This has superseded Bowl Frosting. Bowl Enameling is a coating of rather dense white translucent material applied to the lower portion of the bulb. It is smooth, can be readily cleaned, gives excellent diffusion, is moisture- and heat-proof, not discolored through use and, due to its density, is of relatively low brightness.

There are many styles of reflectors on the market. Detailed information on each is given in Bulletin Index 22. As before mentioned, almost all forms find application in the mill and excellent installations of the following widely diversified types are to be noted: mirrored glass totally indirect, porcelain enameled totally indirect, opalescent glass semi-indirect, metal and glass semi-indirect, opalescent, mirrored and prismatic glass deep bowl direct reflectors, diffusing enclosing units, metal reflectors and diffusing globes and direct lighting steel reflectors.

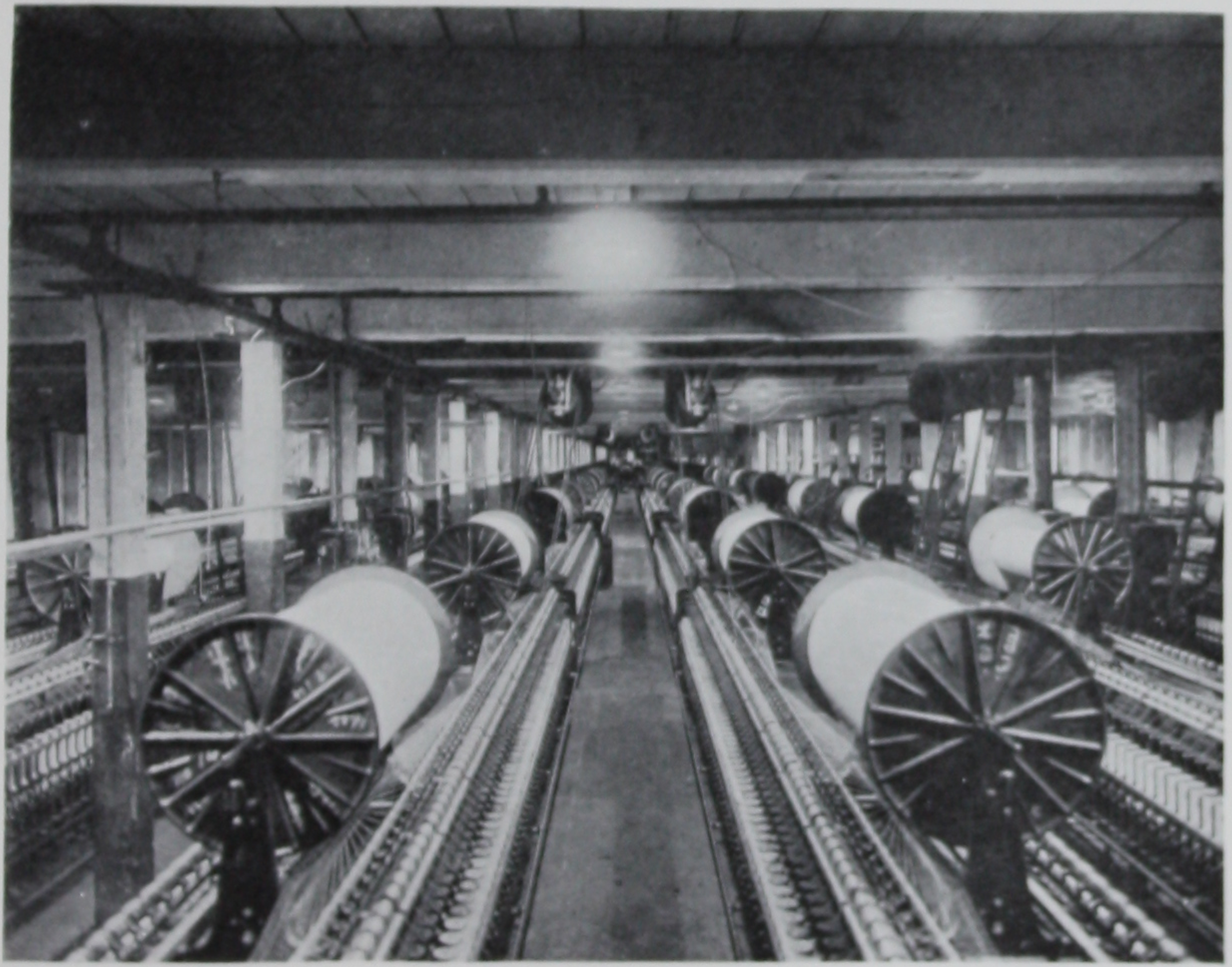

Fig. 4
Night View of a Group of Twisters. Localized general illumination is used on account of the low ceiling. 75-watt units are staggered and located above each aisle

An analysis of the properties and relative advantages of these various equipments would be too lengthy for discussion here. Present practice is tending toward the universal adoption of the RLM Standard Dome reflector and Bowl Enameled Mazda C lamp as the lighting unit for the great majority of industrial processes. The term RLM Standard is derived from "Reflector and Lamp Manufacturer's Standard." This reflector was designed by representatives of the leading manufacturers especially for service with Mazda C lamps. It gives a desirable distribution of light for most purposes, is efficient and built to certain specifications as to light output, gauge of metal used, quality of enamel, angle of cut off, etc. RLM reflectors, while in the process of manufacture, are subject to periodic inspection by representatives of a prominent testing laboratory so that the purchaser can be assured of a high quality. The porcelain enamel finish is particularly advantageous for the surface is virtually glass. It can be easily cleaned and its luster is not destroyed by scrubbing. It is not affected by moisture or acid fumes and after cleaning, it returns to practically initial efficiency.

A new type of reflecting equipment known as the Glassteel Diffuser is just being put on the market by several manufacturers. Although no installations have yet been tried out in the textile industry, the equipment bids fair to be very useful for high grade work where diffusion is especially desired. Its efficiency, using clear lamps, is approximately the same as the RLM reflector with Bowl Enameled lamps. Its important feature is excellent diffusion and minimum glare. It consists of an enameled steel reflector, similar to the RLM Standard, but of larger diameter, and a specially designed opal globe. Small openings in the steel reflector permit about 10 per cent of the light to go directly to the ceiling. Several sizes of lamps can be used advantageously with the same size of reflector, often permitting the changing of the lighting to accommodate a rearrangement of processes, simply by relamping. The field of this equipment is more especially in connection with the higher grades of lighting.

## *Spacing of Outlets and Size of Lamps*

There are certain general rules which might be laid down on the question of the best methods of lighting any interior. Of course, there will be exceptions to these.

From a standpoint of wiring costs, it is desirable to keep the number of outlets at a minimum. Also considering lamp efficiencies, the larger the lamp, the greater the light output per unit of power input. It is obvious that this could be carried to an extreme and make the lighting practically worthless. However, assuming that it is advisable to use large units, let us consider what features limit the size.

### 1. *Ceiling Height*

The angle at which the light strikes the work is controlled by the hanging height. In other words, lamps hung 20 feet above the work on 20-foot centers give the same results as lamps 10 feet above the work and on 10-foot centers. All other items being equal, one 400-watt unit, 20 feet high, will give the corresponding distribution to four 100-watt units 10 feet high.

### 2. *Overhead Obstructions*

If counter-shafting, piping, etc., is present in quantities, it is apparent that bad shadows would be cast by large lamps widely spaced, which might be avoided with small lamps placed more closely together.

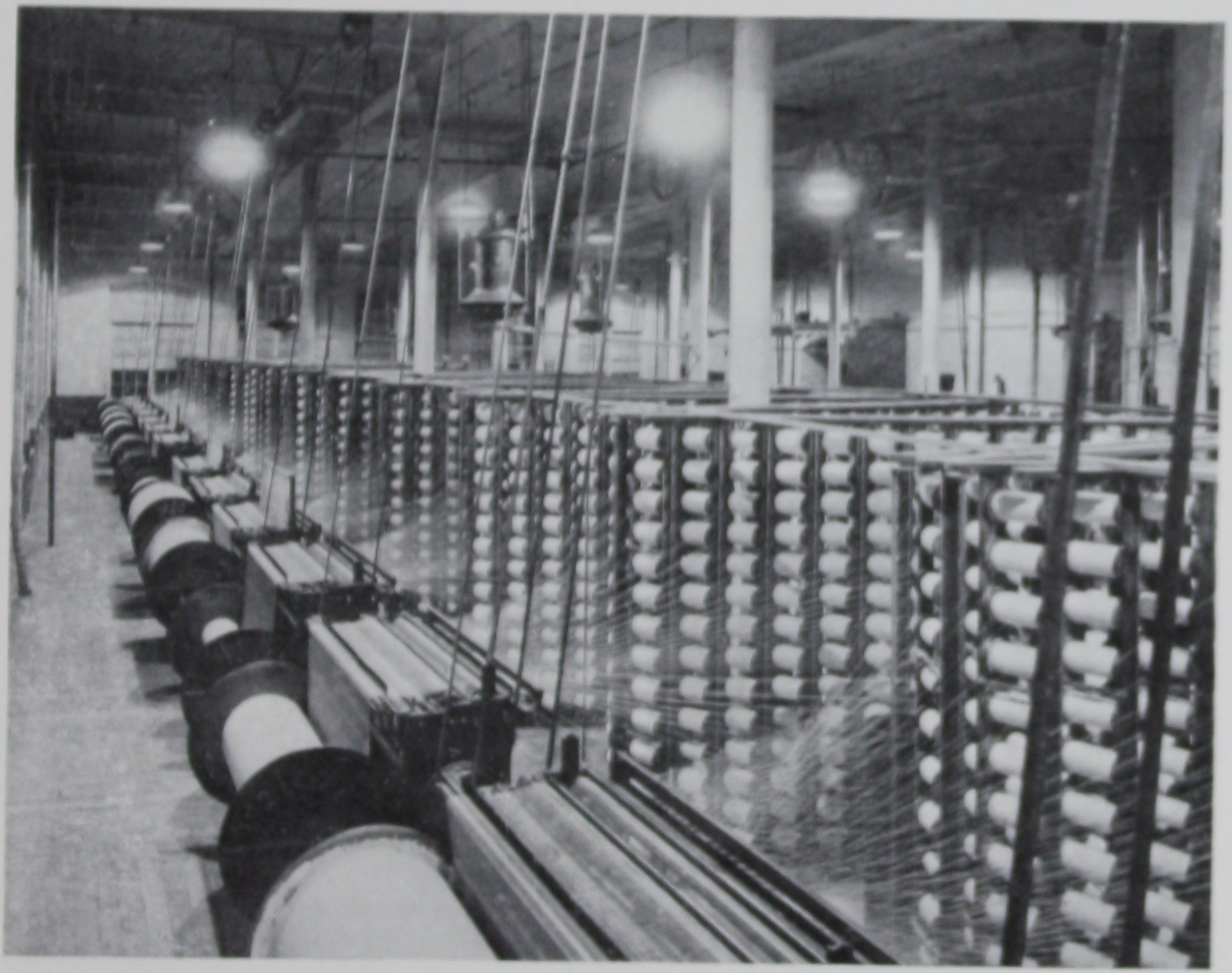

FIG. 5

Cotton Warpers Lighted by the General Symmetric System. 200-watt Bowl Enameled MAZDA C lamps in RLM Standard dome reflectors are used, one outlet in each bay (10 by 25 feet). The intensity is seven foot-candles and the character of illumination such that shadows are minimized

### 3. *Size of Bays*

The mill is usually divided into bays by posts or columns and for the sake of appearance, as well as ease of construction, it is essential to space lamps symmetrically with regard to bays.

### 4. *Overhanging Parts of Machines*

Even if there are no general overhead obstructions, if the machine projects far over the work and lamps are widely spaced, then certain machines, while they may have even lighting on the tops, may produce dense shadows on the work.

### 5. *Color of Walls, Ceiling and General Surroundings*

If these are light-colored, reflecting well, then considerable diffuseness is introduced into the illumination, which eliminates dense shadows. In cotton mills, working on white goods, the illumination on the under sides of machines and harnesses is aided very materially by the light reflected from the warps. Even if reflectors are used which send no light to the ceiling, the white cotton reflects so much light upwards that the ceiling always appears bright.

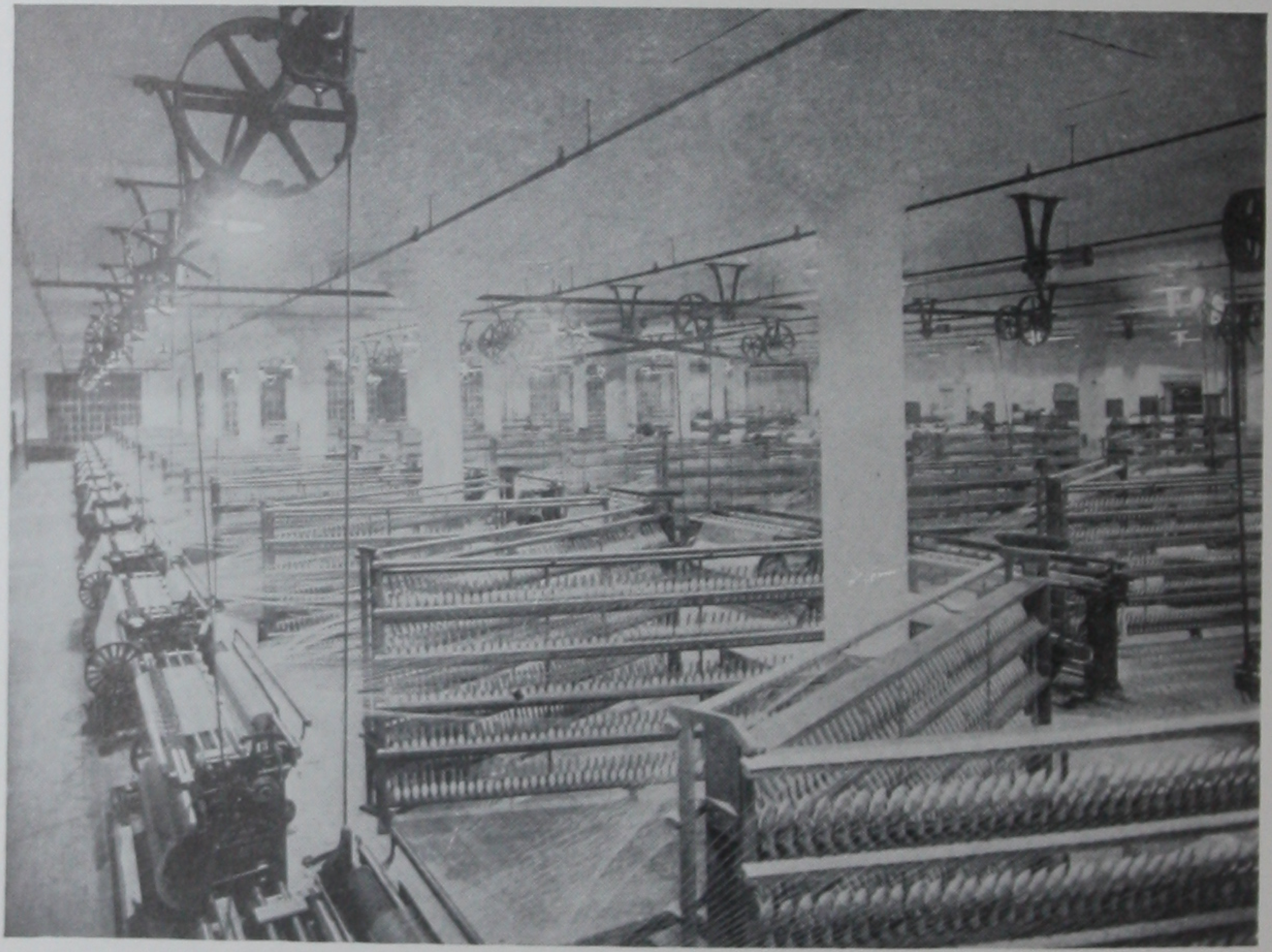

Fig. 6
Due to the High Ceiling in This Room Filled with Worsted Warpers, it is Possible to Use Large Units and Still Have Very Satisfactory Illumination. One 500-watt Mazda C lamp in a distributing type steel reflector is located in the center of each 22-ft. bay close to the 16-ft. ceiling

### 6. *Degree of Accuracy of the Work*

Some processes are very exacting requiring minute inspection, others demand merely enough light to see all parts of the machine clearly.

Where the material is handled in bulk, a low intensity will suffice. In those processes involving single threads, for example, doubling or spinning, moderate general illumination is sufficient. Where threads become grouped together as in weaving and warping and must be distinguished one from the other obviously a high intensity of illumination is necessary.

## *General Lighting Schemes*

Taking all the above items into consideration, it is apparent that one cannot lay down specific recommendations which will cover mills of varying constructions. Assuming that there are no structural parts to interfere seriously with the light, we may lay down certain rough groupings and then analyze the processes in the textile mill as to the group in which each belongs.

The RLM Standard dome reflector and Bowl Enameled MAZDA C lamp as pointed out has become almost the standard equipment for mill lighting. This unit gives out a certain definite amount of light and we can therefore tabulate the necessary spacings for a given size of lamp to produce the desired intensity. These figures can be modified if one desires to use equipment of different efficiencies than this, for example, for indirect systems, the size of lamp at a given spacing must be increased.

On the basis mentioned above, we find three groupings as follows:

*Scheme A.*—Rough work requiring no discernment of detail—general illumination of approximately two and one half foot-candles.

| | | |
|---|---|---|
| Ceiling below 12 ft. | 75-watt units, spacing not exceeding | 12 ft. |
| | 100 | 15 ft. |
| | 150 | 18 ft. |
| Ceiling 12 to 16 ft. | 100 | 15 ft. |
| | 150 | 18 ft. |
| | 200 | 22 ft. |
| Ceiling above 16 ft. | 150 | 18 ft. |
| | 200 | 22 ft. |

*Scheme B.*—Work requiring observation of machine operation and the like—general illumination of approximately five foot-candles.

| | | |
|---|---|---|
| Ceiling below 12 ft. | 100-watt units, spacing not exceeding | 10 ft. |
| | 150 | 13 ft. |
| Ceiling 12 to 16 ft. | 150 | 13 ft. |
| | 200 | 16 ft. |
| Celing above 16 ft. | 200 | 16 ft. |
| | 300 | 20 ft. |

*Scheme C.*—Work requiring discrimination of detail—general illumination of approximately eight foot-candles.

| | | |
|---|---|---|
| Ceiling below 12 ft. | 100-watt units, spacing not exceeding | 8 ft. |
| | 150 | 10 ft. |
| | 200 | 13 ft. |
| Ceiling 12 to 16 ft. | 150 | 10 ft. |
| | 200 | 13 ft. |
| Ceiling above 16 ft. | 200 | 13 ft. |
| | 300 | 16 ft. |

## *Detailed Recommendations for Cotton and Woolen Mills*

In general, the materials handled in woolen mills are darker in color and the fibers more transparent than those in cotton mills. More accurate workmanship is generally required in the woolen mill for the value of the product is greater. Consequently, for the same operation it is necessary to provide somewhat higher illumination in the woolen mill.

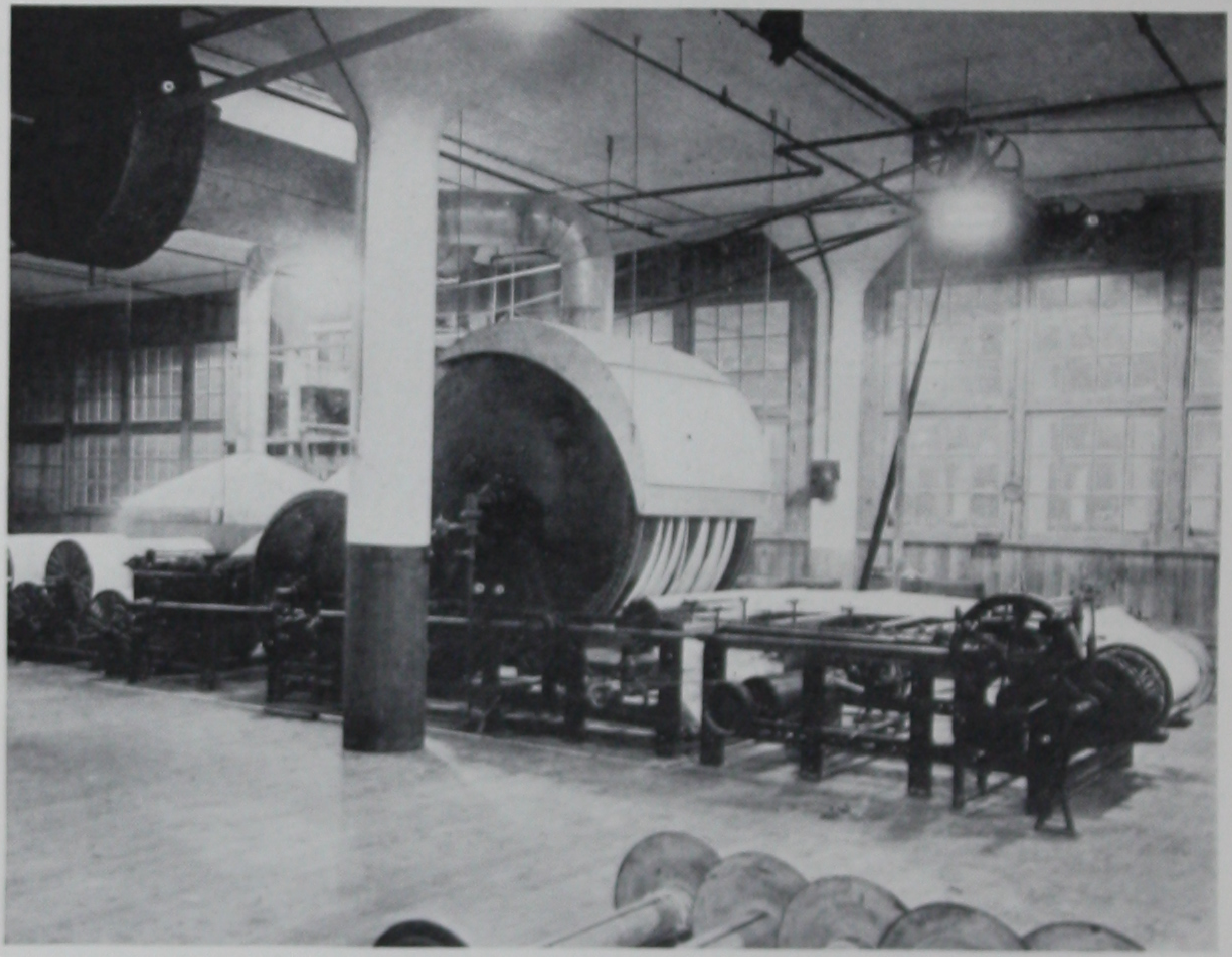

FIG. 7
A Slasher as it Appears by Night, Illuminated to an Intensity of Five Foot-Candles. All parts of the machinery are visible and material can be handled with speed. The staggered arrangement of 200-watt units is followed

### *Bale Breakers, Openers and Pickers (Cotton)*

The work done in these departments is not in the least exacting. Material is handled in bulk and there is no demand for close vision. Safe operation, however, requires that all moving parts be clearly visible, and a more cheerful place in which to work is secured with general lighting. A layout in accordance with Scheme A will provide an adequate intensity for these processes. Fig. 1 shows a room of this character as it appears by night with the recommended illumination.

*Sorting, Degreasing and Washing (Wool)*

Low intensity general illumination, Scheme A, meets the requirements of these processes, as the work carried on is not exacting. With certain arrangements of washing machines, it is possible to employ the general system, but for most layouts better results can be obtained by locating 100- or 150-watt Bowl Enameled Mazda C lamps in RLM Standard dome reflectors over the entrance and delivery ends of the machines, eight to ten feet above the floor. This arrangement provides maximum light where most needed and gives an adequate spread for the surrounding areas.

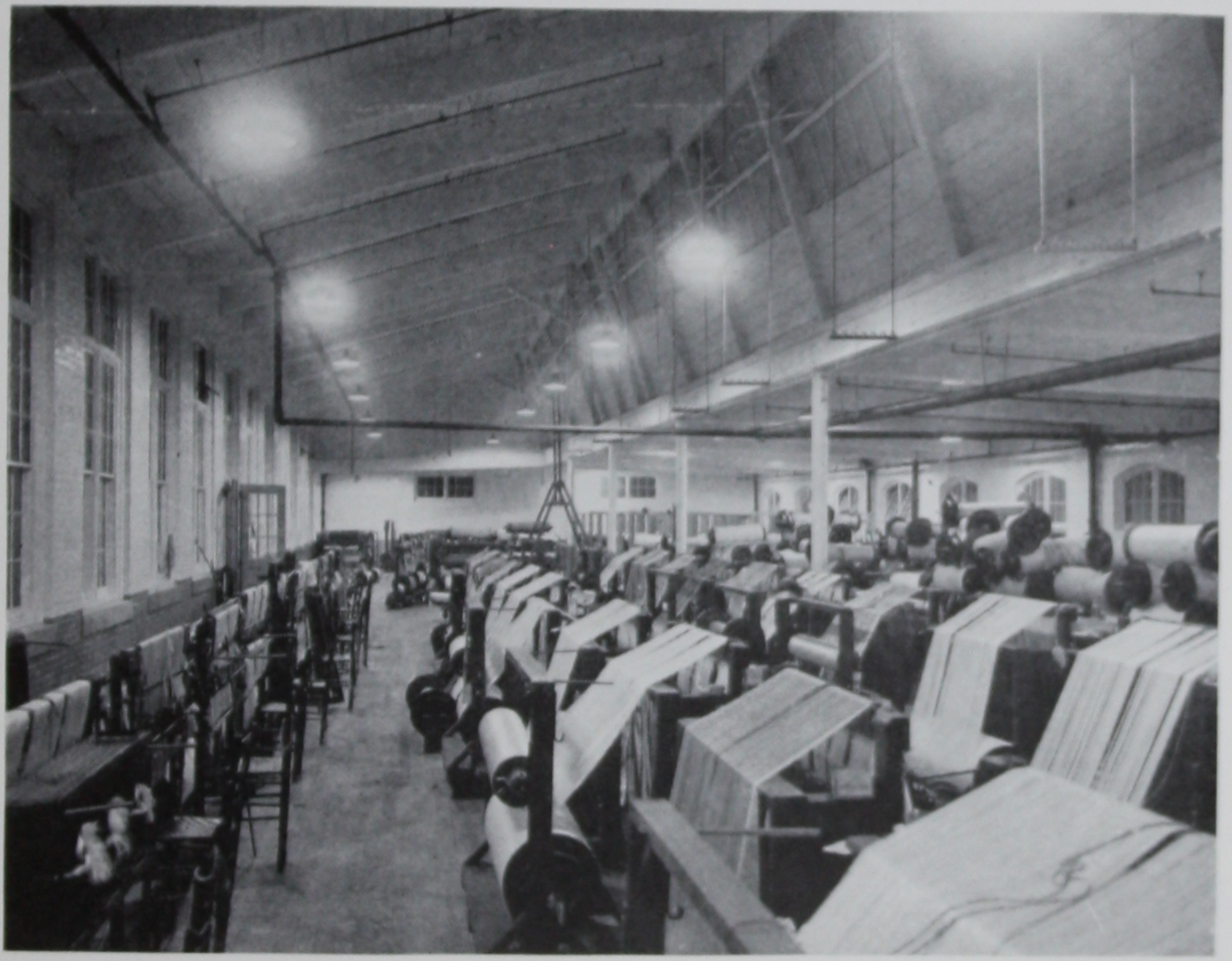

Fig. 8

As Mentioned in the Text, Drawing-in is a Process with Exacting Visual Demands. Before the effect of light was fully appreciated, we saw many unprotected drop lamps close to the operator's eye. Here is a room in which it is pleasant and comfortable to work, between six and seven foot-candles of well diffused illumination is available throughout. The lighting is accomplished by the use of 200-watt units of the standard type placed well out of the angle of view

*Cards, Combs, Gills, Drawing Frames and Slubbers (Cotton and Wool)*

The material has not yet been reduced any great amount in size and a low intensity will prove reasonably satisfactory. From the standpoint of safety, with the rapidly moving parts on every hand, better practice favors the moderate intensity of general illumination as produced by Scheme B. Fig. 2 shows cards and drawing frames lighted to an intensity of seven foot-candles.

*Intermediates, Speeders, Spinning Frames, Twisters and Spoolers (Cotton and Wool)*

It is true that the yarn becomes successively smaller in each of these processes, yet they present the same lighting requirements with demands for an increasing quantity of light as the yarn approaches completion. Good illumination on vertical surfaces is very necessary here and a reflector which concentrates the light is therefore not applicable. The spread light from the RLM Standard dome equipment is of decided advantage.

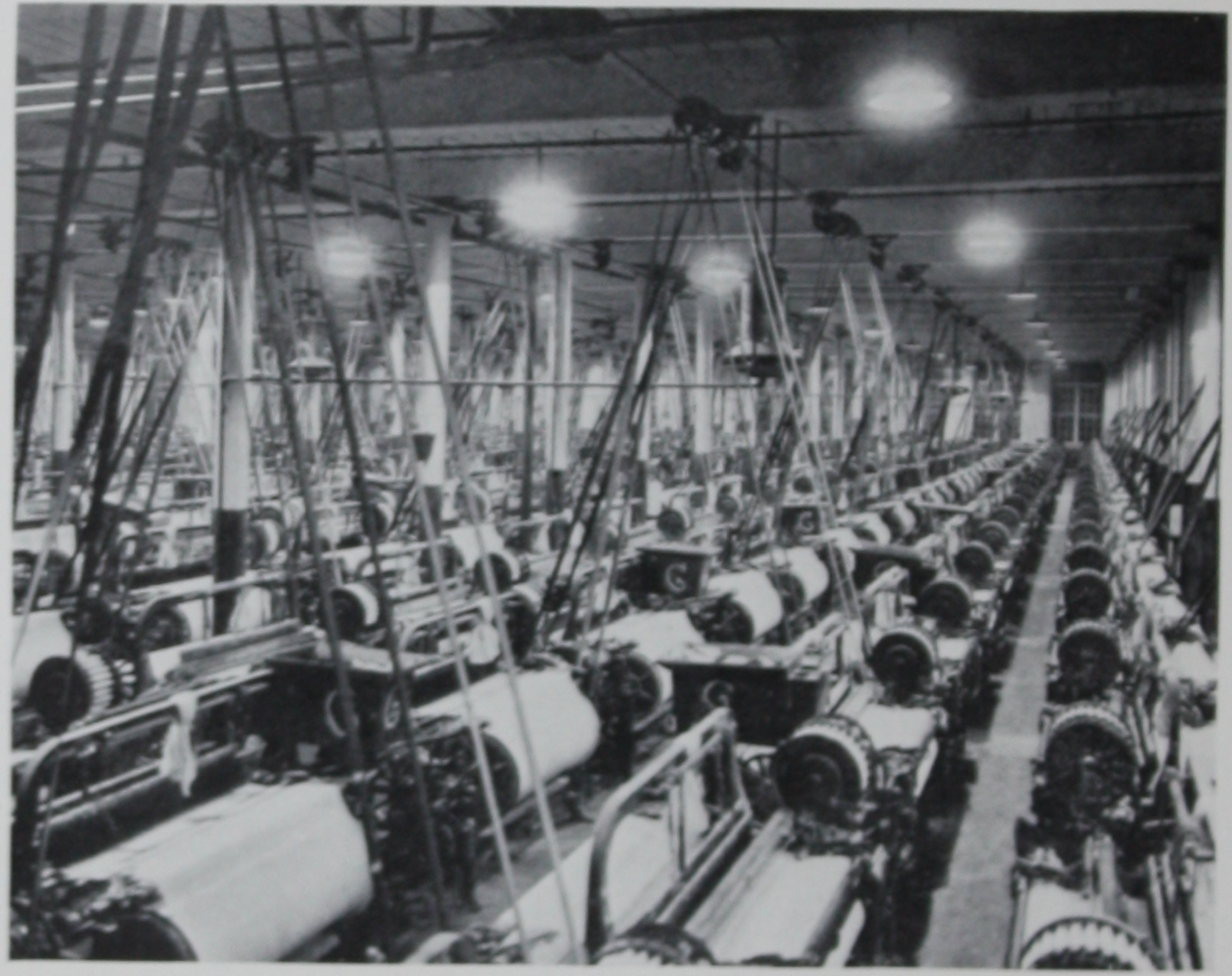

Fig. 9

Where There are Overhead Shafts and Belts, Special Care Should be Used in Designing a General Lighting Installation to Avoid Objectionable Shadows. The location of outlets is especially important. Here is a cotton weave shed illuminated by 200-watt Bowl Enameled Mazda C lamps in RLM Standard dome reflectors on 20-ft. centers above the weavers' alley. A carefully conducted test showed the intensity to average over six and one-half foot-candles

If lamps can be located a reasonable distance above the tops of machines (at least six feet) Scheme B general illumination will prove well suited. For spinning dyed or mixed cotton yarns and wool it is well to employ a higher intensity as produced by Scheme C. With all these machines, it is rather desirable to have the outlets symmetrical with the work aisles even though strictly general illumination is applied. An example of this arrangement is to be seen in Fig. 3.

If the ceiling is low and the frames high, it is quite apparent that outlets must be located over the work aisles. 100- and 150-watt units are used for this purpose on centers from ten to sixteen feet. Fig. 4 shows this localized general lighting scheme applied to twisters in a low ceiling room.

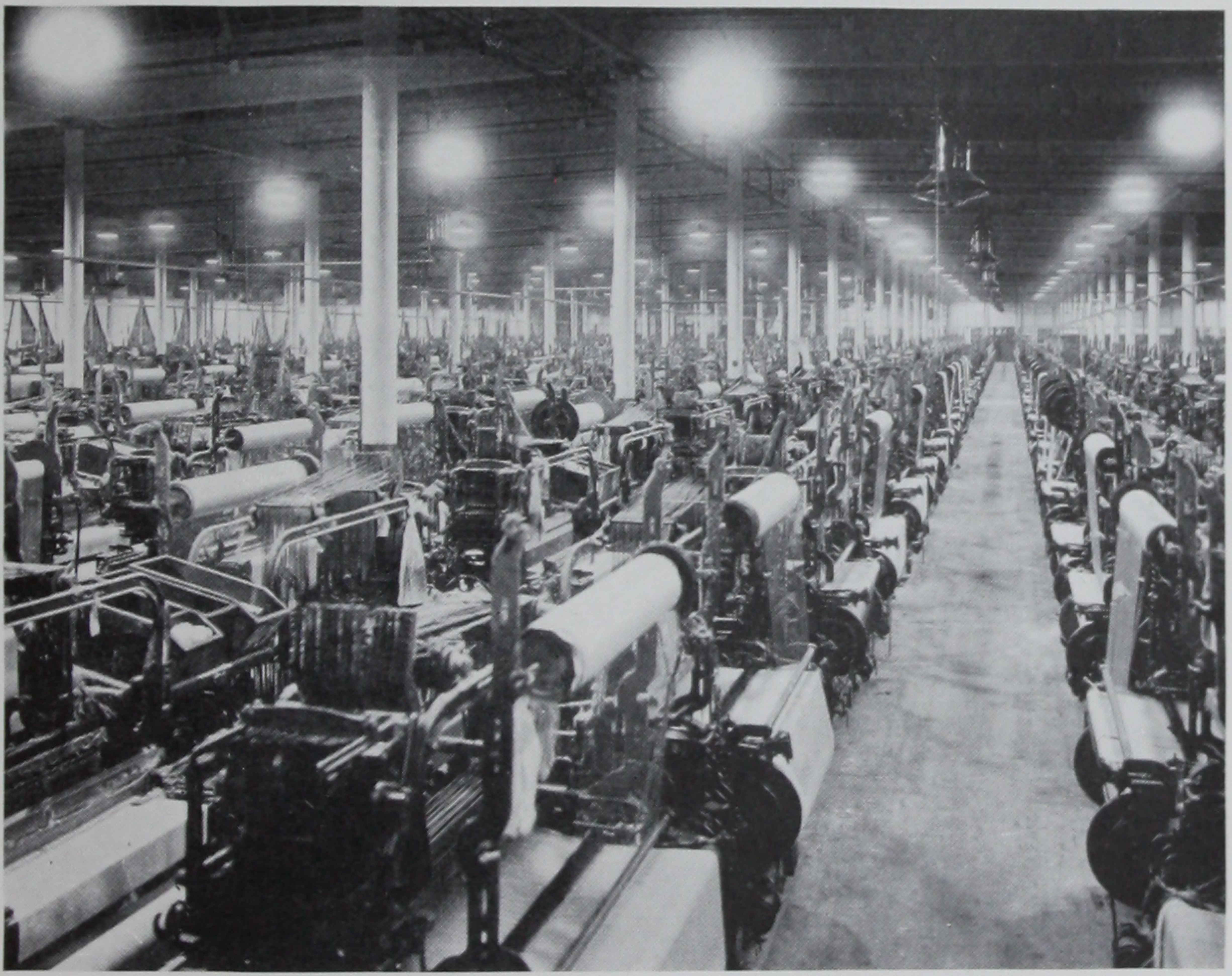

FIG. 10

A Somewhat More Modern Type of Weave Shed with Individual Machine Drive. These 1200 looms are lighted by the general system employing 200-watt units 14 feet above the floor. The intensity on both the horizontal and vertical planes after the installation had been in operation for several months averaged five foot-candles

For mule spinners in the woolen mill the general system of illumination is applicable, although it is advisable to locate the lighting units in rows over the machines and at the end of the travel.

### *Warpers (Cotton and Wool)*

This is one of the most exacting processes in the mill for each thread must be seen distinctly as it passes from the creel to the beam. Some mills still utilize the localized general lighting system where a 75- or 100-watt Mazda lamp in a suitable reflector is hung above each reed and creel. In other instances, well diffused high intensity general illumination (Figs. 5 and 6) as provided by Scheme C is used with very satisfactory results. The precaution should be taken that lighting outlets are not placed so that the operator works in a shadow when tying a broken warp.

### *Slashers (Cotton and Wool)*

Either low or moderate intensity general illumination (layouts A or B) can be applied to the room where the slashers are located. Precaution should be taken to so arrange the position of outlets as to minimize the shadows from the overhanging hood and provide particularly good illumination at the head end as in Fig. 7. A convenience outlet to which a hand or portable lamp can be attached is necessary in order that the starch boxes can be inspected.

### *Drawing-in Frames (Cotton and Wool)*

The uninitiated often marvels at the speed of the operators in this department. Needless to say, the work presents exacting visual requirements. A high intensity of illumination is necessary from economic and humanitarian reasons. The component of light on vertical surfaces must be of a high order. Light-colored surroundings will do much to introduce this and give diffusion. A Drawing-in Department well equipped as to lighting and surroundings is pictured in Fig. 8. Scheme C general illumination is used.

### *Tying-in Machine*

The tying-in machine is frequently placed close to the wall and the nearest lighting unit so located that the operator casts a shadow on the mechanism when picking up a thread. This question must be given especial consideration and lighting so planned that even when making the adjustment a high intensity of light is still available on the working point.

### *Looms (Cotton and Wool)*

The Weave Shed is undoubtedly the part of the mill which does and should receive the most attention in regard to the lighting. With poor illumination and resultant faulty work, a distinct financial loss results. It is necessary for the operator to detect at once any flaw in the cloth, to thread the harnesses when the warp becomes broken, and make other adjustments. A few years ago, it was deemed essential to have a drop or local lamp close to the work over each harness with possibly an additional low candle-power lamp in the rear alley. Recent practice, however, has proven that high intensity general illumination (Scheme C) with all its advantages is very suitable for this work, as indicated by Figs. 9, 10 and 11.

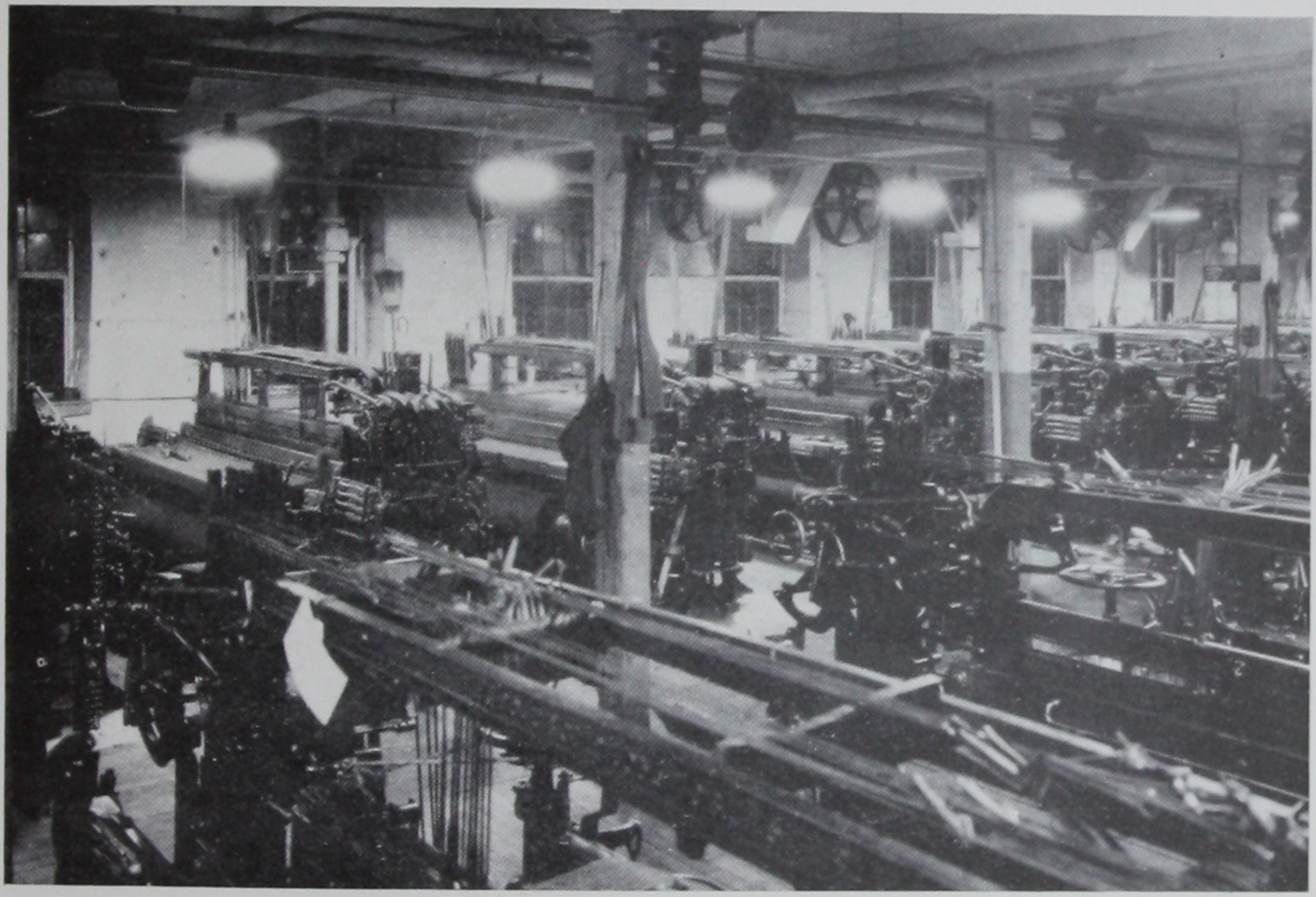

FIG. 11
The Weave Shed of a Woolen Company which Believes in High Level Lighting. In this case 300-watt Bowl Enameled MAZDA C lamps in RLM Standard dome reflectors replaced 75-watt local units. An intensity of from 17 to 20 foot-candles prevails in the areas occupied by the looms

Where there are very low ceilings and where the belting from overhead drive is a serious factor, it is sometimes necessary to apply the localized general lighting scheme. If white goods are being made on looms of standard width, the proper localized general lighting will be provided by having an outlet above the weaver's alley between every second pair of machines, this outlet supplying a 150-watt Bowl Enameled MAZDA C lamp in an RLM Standard dome reflector about nine feet above the floor. The mistake should not be made of placing the lighting unit directly in front of the loom, for the weaver will cast a shadow at the working point.

For wide looms (54- to 72-in. goods) one 100-watt unit of the same type should be installed between each pair of machines over the weaver's alley.

Where dark goods are being made on either size of loom, the next larger lamp should be employed with the outlets arranged as stated. The distribution of light from any of the schemes suggested is such that the rear alley will be well lighted. There will be plenty of "cross-light" and shadows minimized.

*Inspection Department or Cloth Room*

This area should be provided with high level general illumination (Scheme C), Fig. 13. Where goods of different colors or bleached and unbleached material is handled, the Mazda C Daylight lamp is decidedly of service. This form of illuminant, however, is not correct for discriminating color matching. To check up the product in the final inspection work, it is most desirable to have the accurate type of color identification unit available. More complete information on this subject will be found in Bulletin Index 43, "Artificial Daylight for Merchandising and Industry."

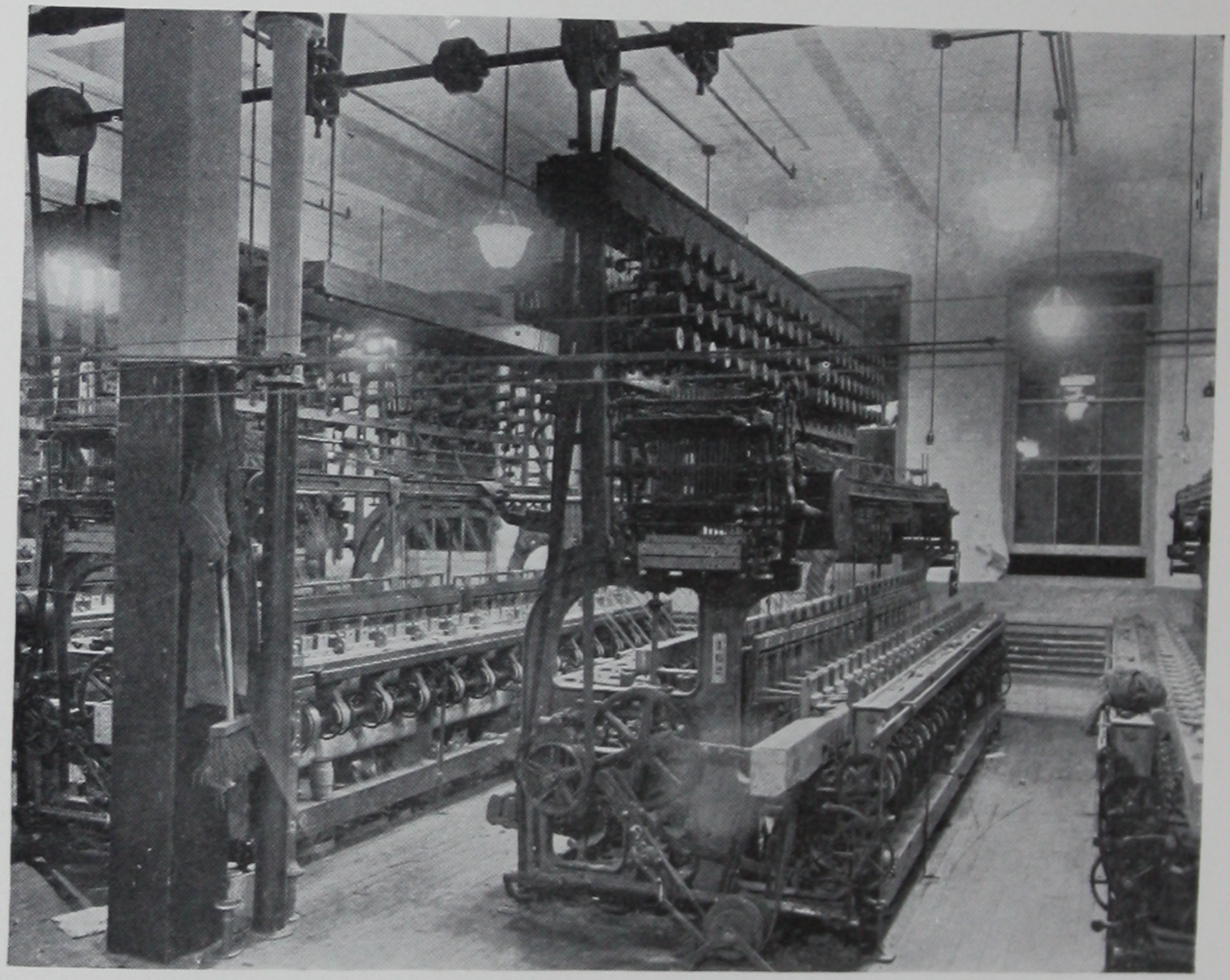

Fig. 12

To Properly Illuminate These Tape Looms with the High Racks which Cast Shadows, is Somewhat of a Problem. The light ceiling makes semi-indirect illumination practicable. 200-watt clear Mazda C lamps in dense opal glass bowls on 10-ft. centers provide the well diffused illumination essential for such conditions as pictured

Perching requires that vertical surfaces be illuminated to a high intensity (50 foot-candles and upwards). This effect can best be secured through the use of angle type units rather closely spaced in front of the frame. Many mill men believe that efficient and accurate work cannot be done by artificial light, but this does not hold. If the color of light from the Mazda lamp is modified by suitable absorbing screens, constant north sky quality is available.

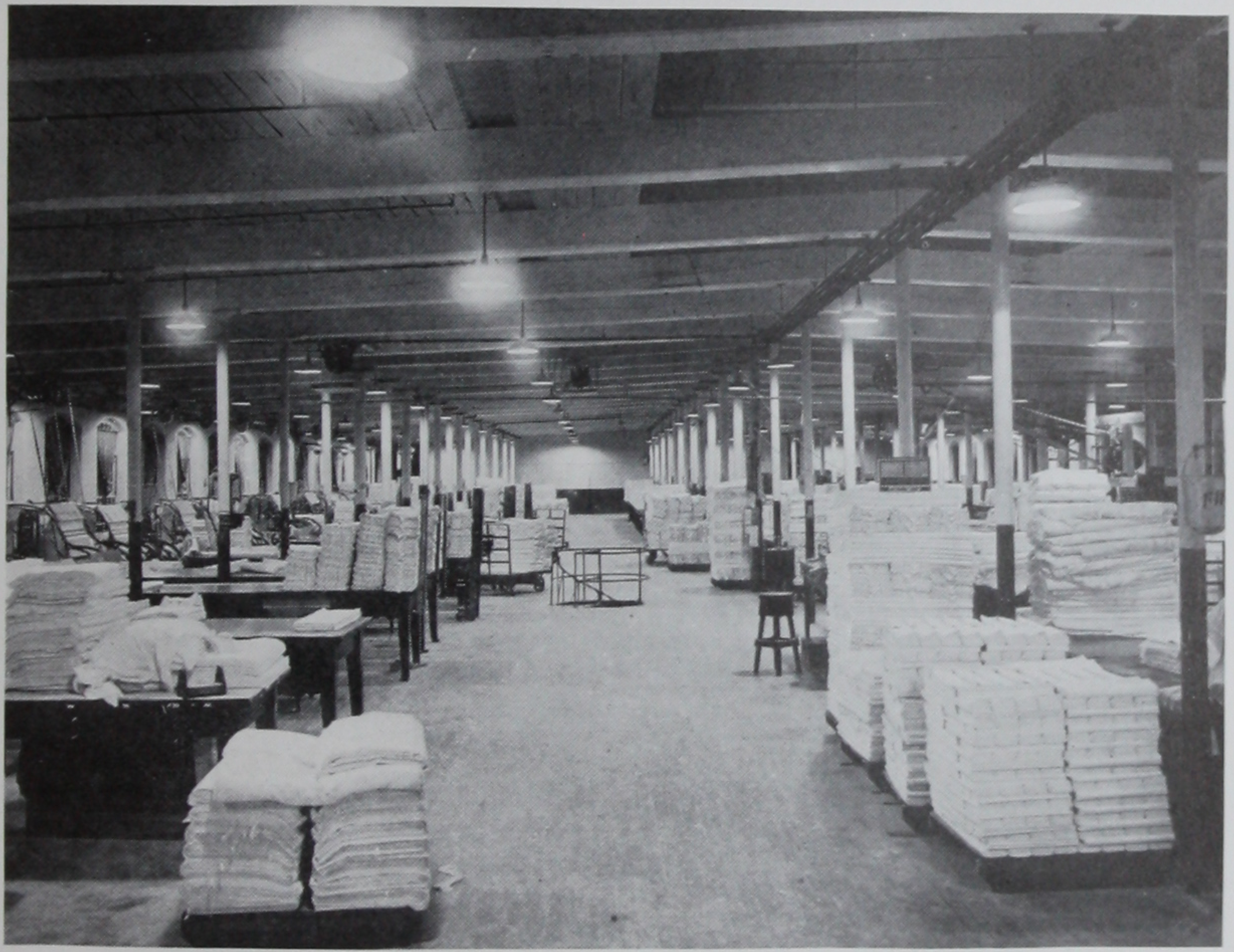

Fig. 13
Night View of a Cloth Room well Illuminated by 200-watt Bowl Enameled Mazda C Lamps and RLM Standard Dome Reflectors Placed 11 Feet Above the Floor on 10 x 20-ft. Centers. An average intensity of eight foot-candles is produced

To obtain the necessary color modification and intensity, a high wattage (from 1500 to 4000 watts, depending on the character of the cloth) must be used at each frame. In spite of this fact the advantages of working independent of daylight are such that a number of installations of color modifying units are in service and proving their worth in insuring a quality product and saving time.

*Packing and Shipping*

The methods outlined under Schemes A and B will prove suitable here depending on the character of the work, the lower intensity being adequate for rough work.

## *Detailed Recommendations for Silk Mills*

### *Throwing Frames, Winders and Quillers*

With these machines, it is necessary that the light be such that the operator can readily detect spent spools, broken threads and the like from any position in the aisle.

Formerly, under the localized lighting used, the operator was compelled to move the light back and forth to the source of trouble. Ofttimes, the part of the frame between units was neglected because the operator could not discern trouble in these areas on account of little or no light. With the appreciation of this fact and also of the excessive lamp breakage, the lamps were gradually raised higher and higher until the cones of light from adjacent lamps over-lapped and the dark spots disappeared. As a result, moderate intensity general illumination (Scheme B) came into use, Figs. 14 and 15.

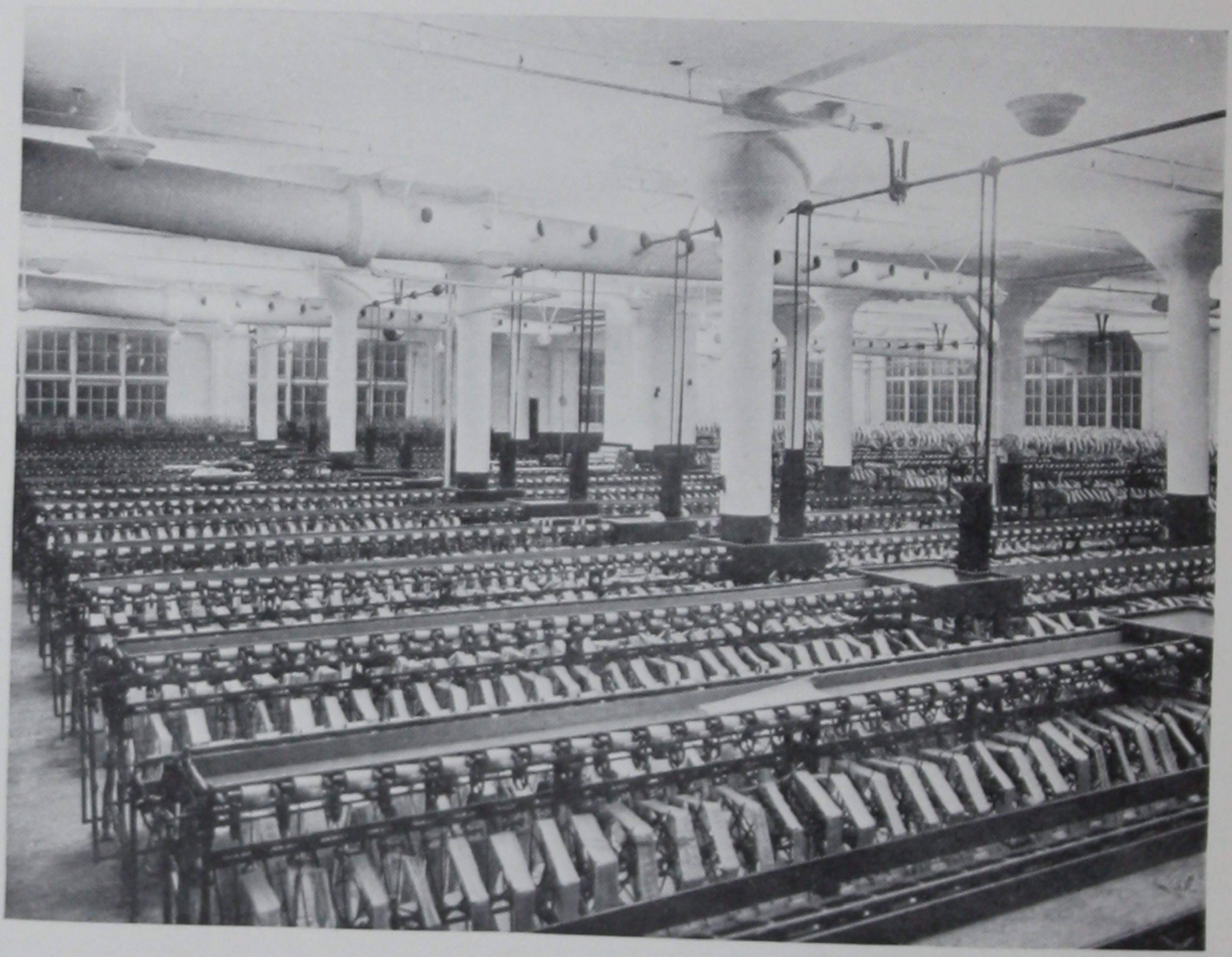

FIG. 14
Night View Single and Double Deck Silk Winders Lighted by 200-watt MAZDA C Lamps in Mirrored Glass Totally Indirect Luminaires. Two outlets are staggered in each bay, power consumption being one watt per square foot of floor area

It is necessary in preparatory processes where dark soft silk is used continually or where universal machines are used and quilling is performed directly from the skeins, or where the revolving swifts of the winders are located at the top of the frames, to space lamps more closely and use the higher intensity provided by Scheme C.

*Horizontal Warpers*

Since the reel of the horizontal warper is sometimes eight yards in circumference, it is necessary that outlets be carefully placed for, when full, the reel presents a wall shutting off the light from those areas back of it.

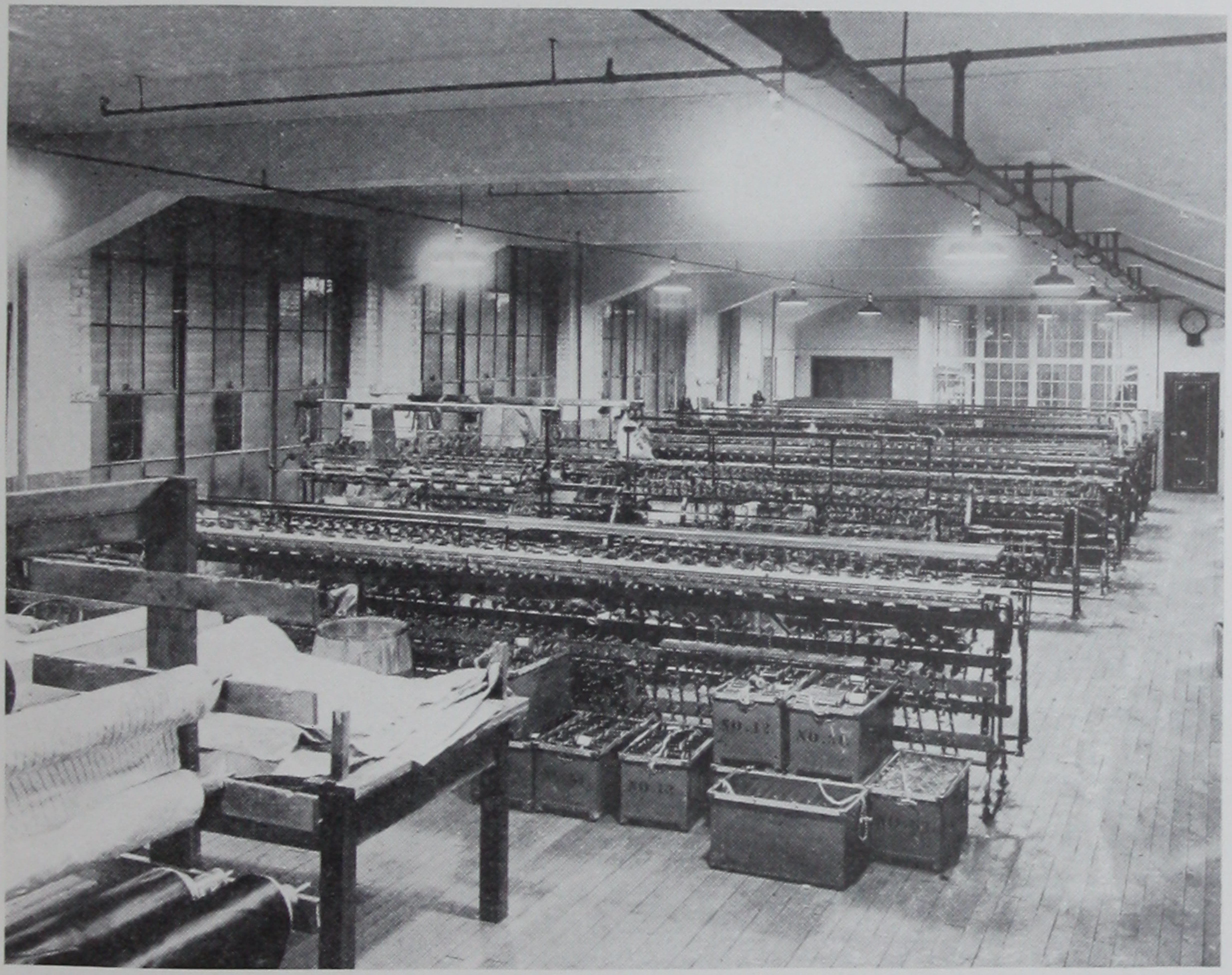

Fig. 15

Moderate Intensity General Illumination (Five Foot-Candles) is Provided on These Winding and Quilling Frames by 200-watt Bowl Enameled Mazda C Lamps in RLM Standard Dome Reflectors on 12-ft Centers, 10 feet above the floor

To light an isolated warper of this type, 75- or 100-watt Bowl Enameled Mazda C lamps and RLM Standard dome reflectors should be placed about nine feet above the floor at each end of the beam. This arrangement will eliminate the shadow of the operator when "beaming off." It may be necessary to experiment as to the exact height, so that reflections from the reel when revolving are not annoying to the worker.

Where there are a number of machines, they are usually arranged in rows with the beam ends facing, forming an alley between, in which the operators work. In this case, the same type of unit should be placed between pairs of machines and centered on the alley.

The creels can be well lighted by a similarly placed row of 75-watt units. In the case of the isolated machine, a single unit will suffice for the creel.

The reed is the really critical part of the machine and this can well have a very high intensity of illumination from a local or drop unit. A 50- or 75-watt White Mazda lamp in a deep bowl steel reflector should be hung fairly close to the working point.

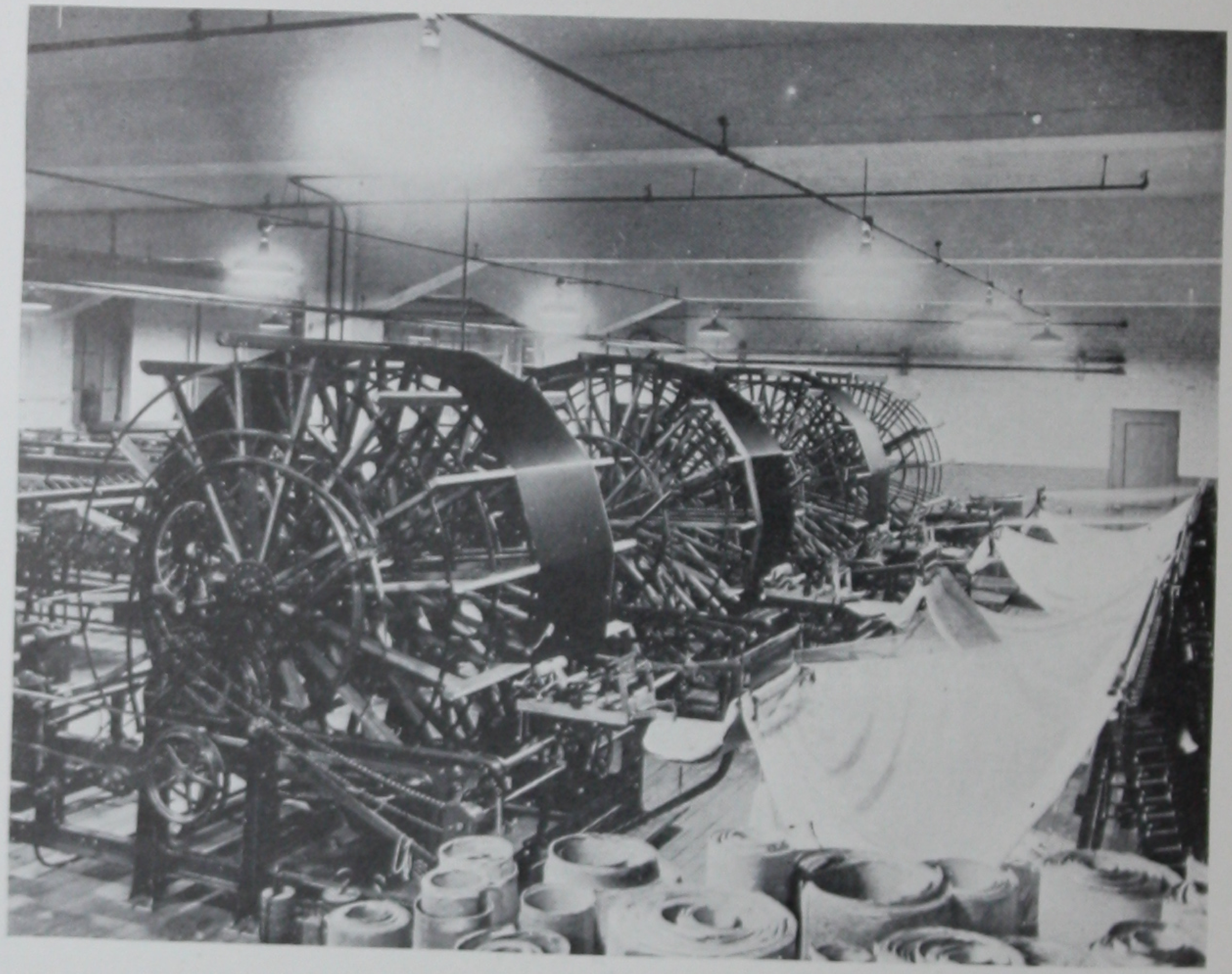

Fig. 16
If the Outlets are Placed in the Correct Positions, General Illumination is Quite Feasible for Horizontal Warpers. Here 200-watt units are used on 12-ft. centers

On the other hand, in a number of cases, mills have installed regularly arranged, high intensity, illumination as pictured in Fig. 16 and have been very well satisfied with the results secured.

*Swiss Warpers*

Compared with the horizontal type machine, the Swiss warper is quite compact and does not require the same degree of care in the placement of outlets. The reel or beam is seldom over three yards in circumference and hence not high enough to cast objectionable shadows. The reed is somewhat wider permitting a greater distribution of threads and the creel usually smaller and more compact. All these factors combine to make well diffused general illumination of a high intensity (Scheme C) practicable, as illustrated in Fig. 17.

If the room is finished in light colors and there are no overhead obstructions, indirect systems of lighting can be well applied for this process. The excellent diffusion produced eliminates annoying shadows.

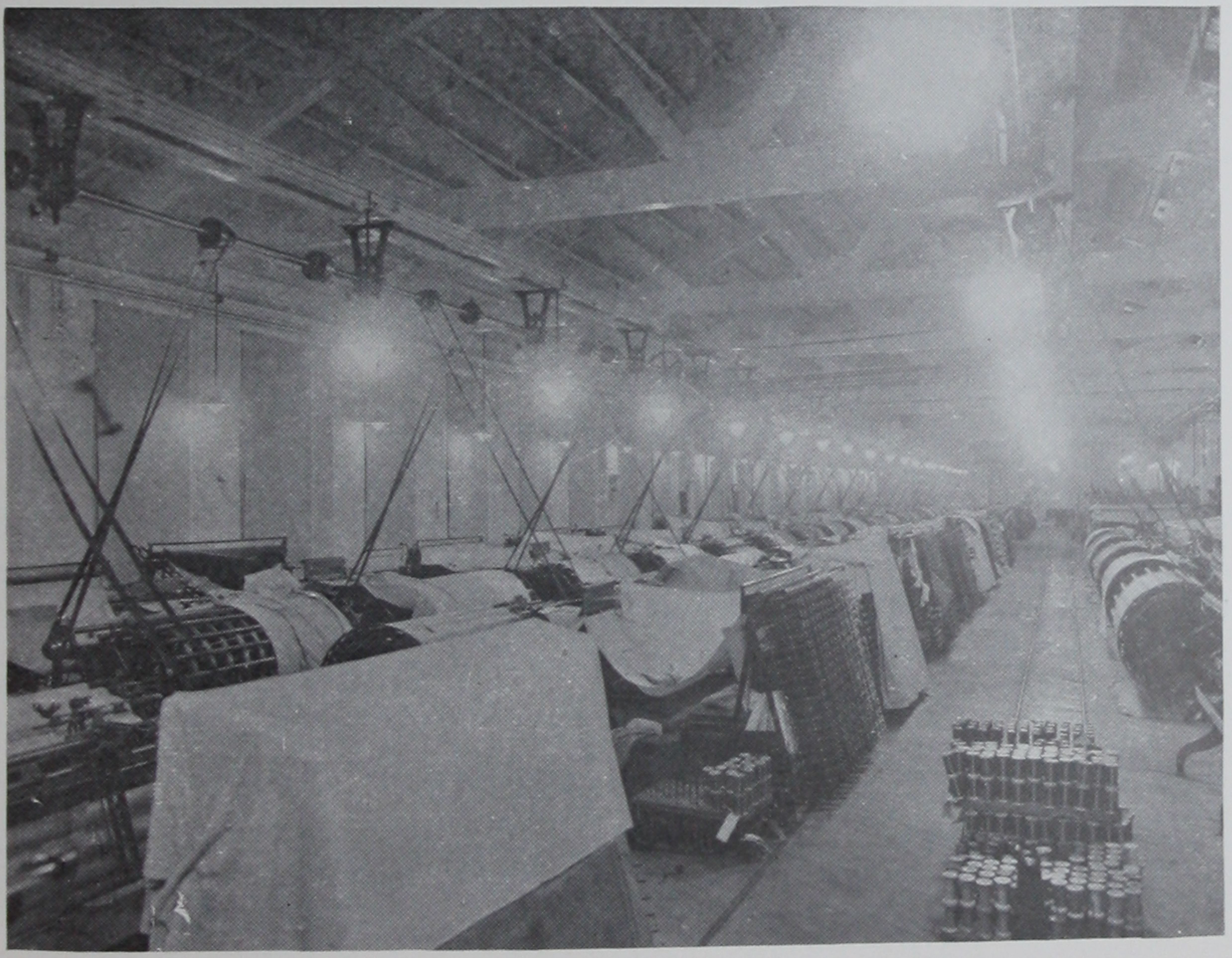

FIG. 17
An Example of the Use of Opalescent Enclosing Globes with External Metal Reflectors. 100- and 200-watt MAZDA C lamps are used in this equipment on centers 10 by 12 feet. The diffused illumination is excellent for the character of work done on these Swiss warpers

*Looms*

As with the cotton and wool industry, weaving is the most important operation in the mill and lighting of the looms must receive the most careful attention. In this operation more than in any other, the personal element plays a large part. Mistakes in weaving are disastrous and costly because in this process is involved the work of all other steps in manufacture.

For plain or box looms, where the number of shafts is not greater than five, the high intensity general illumination (Scheme C) can be applied to good advantage, providing structural conditions are such as to have a minimum of overhead obstructions and give sufficient hanging height. Where there is considerable belting, or where the ceiling is low, the localized general arrangement with a 200-watt unit placed between rows of looms, one such unit to every four machines, is necessary, see Fig. 18.

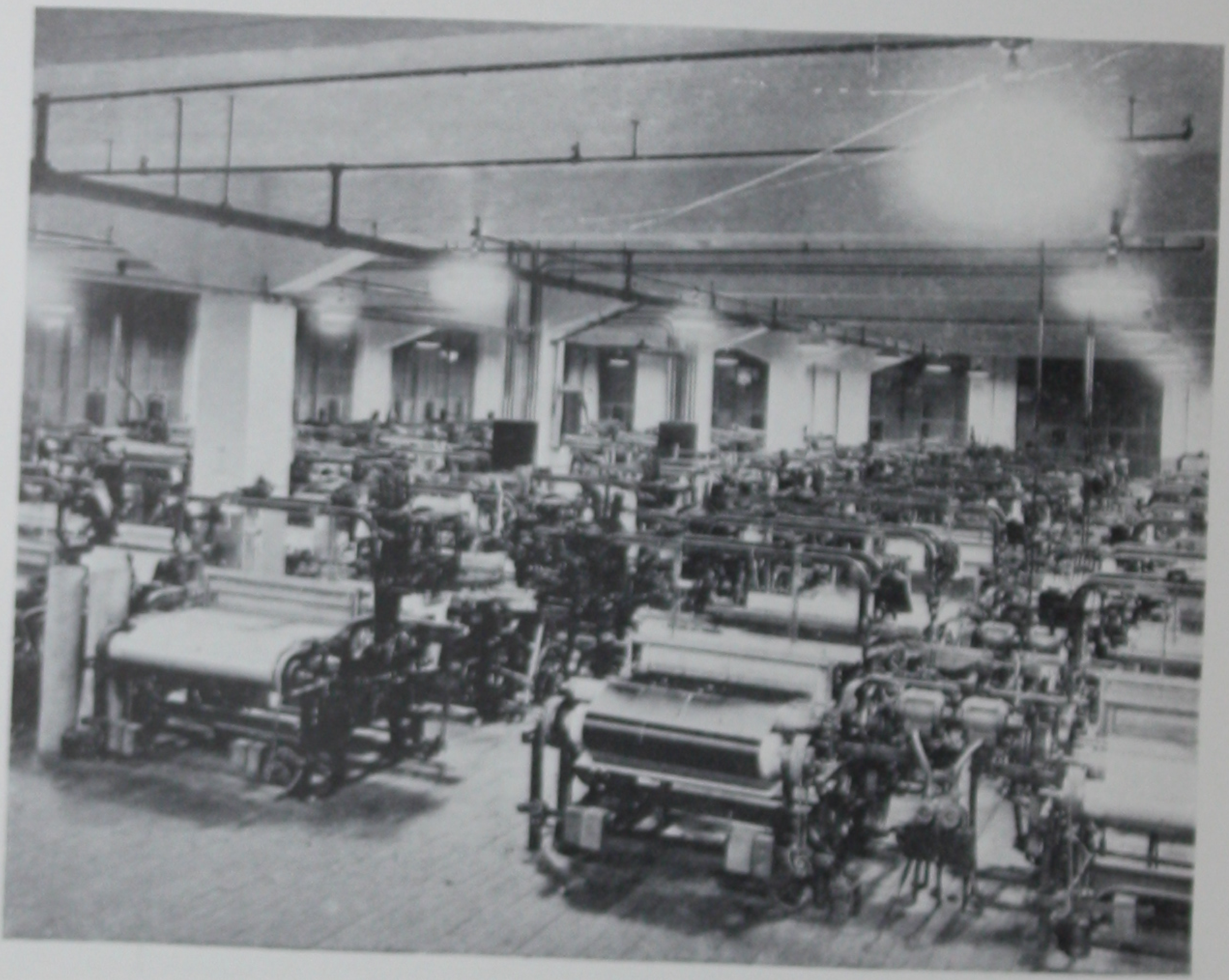

Fig. 18
These Silk Looms are Lighted in Accordance with the Arrangement Recommended in the Text. One 200-watt unit, 10 feet above the floor, serves four looms and provides good general illumination

Where the number of shafts is considerable or where Jacquard looms are used, it becomes very difficult to supply adequate illumination by any other than a localized system with lamps well shaded. With general illumination it would be extremely hard to thread the eye of the heddle on account of shadows from overhanging parts.

Individual types of machines and general arrangement have to be studied and it is difficult to set forth any general rule. In most instances, 50- and 75-watt White Mazda lamps with deep bowl reflectors are suitable. Such units should be hung over the harness or between the harness and the reed and provided with an extension cord long enough to permit placing of the lamps to the best advantage when trouble occurs. Such an arrangement is pictured in Fig. 19.

In addition to this local lighting of the loom, general illumination of a medium intensity must also be provided. The aisles and passageways between machines must be well lighted for safety. Relatively bright surroundings are necessary to prevent severe contrast and resultant eyestrain. When local lighting is used the constant readjustment of the operator's eye as he shifts his gaze back and forth from the brightly lighted lay to the darker surroundings is likely to cause excessive eyestrain and fatigue.

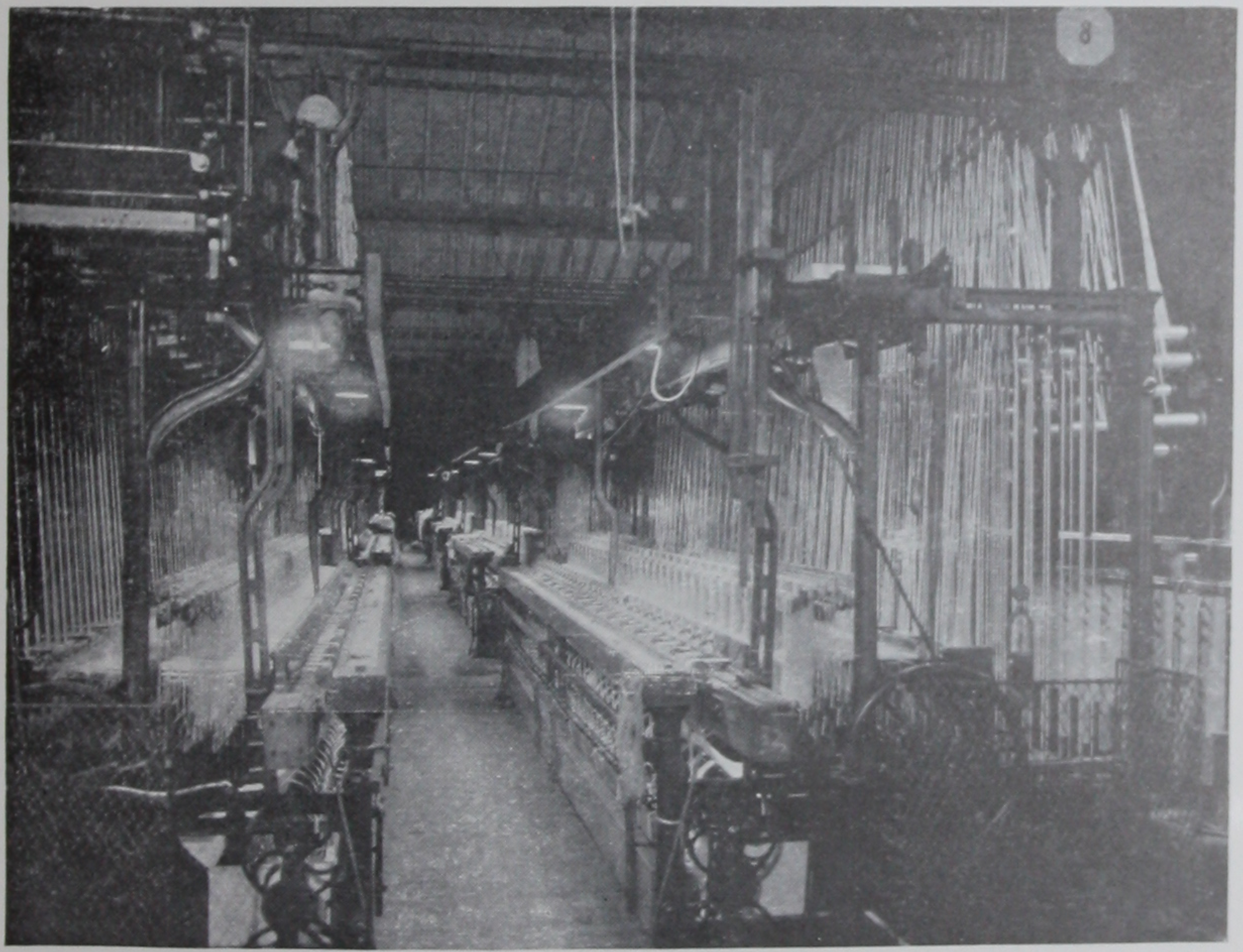

FIG. 19
Local Lighting is Sometimes Necessary where Complicated Machinery, Such as These Silk Ribbon Looms, is Encountered. The ceiling in this instance was not well suited to the indirect systems, so 60-watt MAZDA lamps in deep bowl reflectors are localized with reference to machines

## *Detailed Recommendations for Bleacheries and Dye Houses*

### *Opening, Laying Out and Sewing (Gray Goods)*

Low intensity general illumination is adequate in the portion of the plant devoted to these processes, save that a local lamp

(25-watt Mazda B with deep bowl reflector) should be installed at the sewing machine.

*Singeing*

Here care should be taken to place the lighting units so that the shadow from the hood is minimized.

*Washing, Boiling, Chemicking and Souring*

In all these processes with the material in rope form, the low intensity general illumination layout (Scheme A) will be satisfactory for there is no exacting visual work and the material proceeds automatically on its journey. Outlets should be so placed in regard to the boilers and vats that the interiors are not in dense shadow, see Figs. 21 and 22.

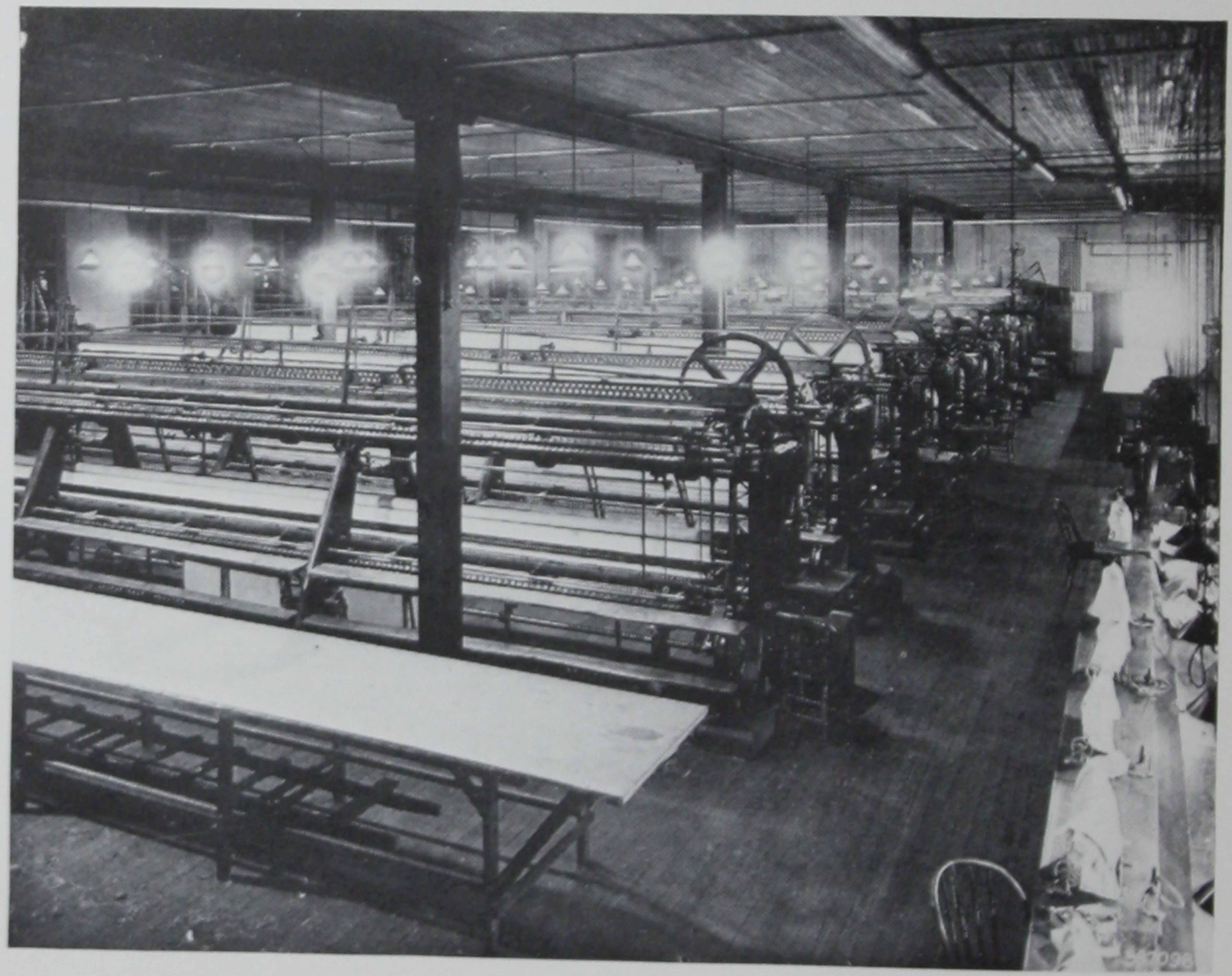

Fig. 20
Night View of Embroidery Machines with Localized General Illumination. 100-watt Bowl Enameled Mazda C lamps are placed on 8-ft. centers eight feet above the floor. The glass top dome reflector is used. This transmits some of the light, rendering the ceiling luminous and the room more cheerful

In all parts of the plant where steam or chemical fumes are present in large quantities, vapor-proof fittings are desirable to prevent corrosion of the lamp base and socket parts. It is sometimes necessary to coat the wiring conduit with asphaltum paint as an additional precaution.

### *Water Mangling, Starching, Back Filling, Drawing, Sprinkling and Calendering*

As the material is now in open widths and it is necessary to observe the moving cloth at certain points, medium intensity general illumination (Scheme B) should be applied to these departments. Most of the machinery is in a vertical plane, Fig. 23, so reflecting equipment emitting light at angles near the horizontal is necessary. The RLM Standard dome is suitable if it can be hung somewhat above the tops of the machines.

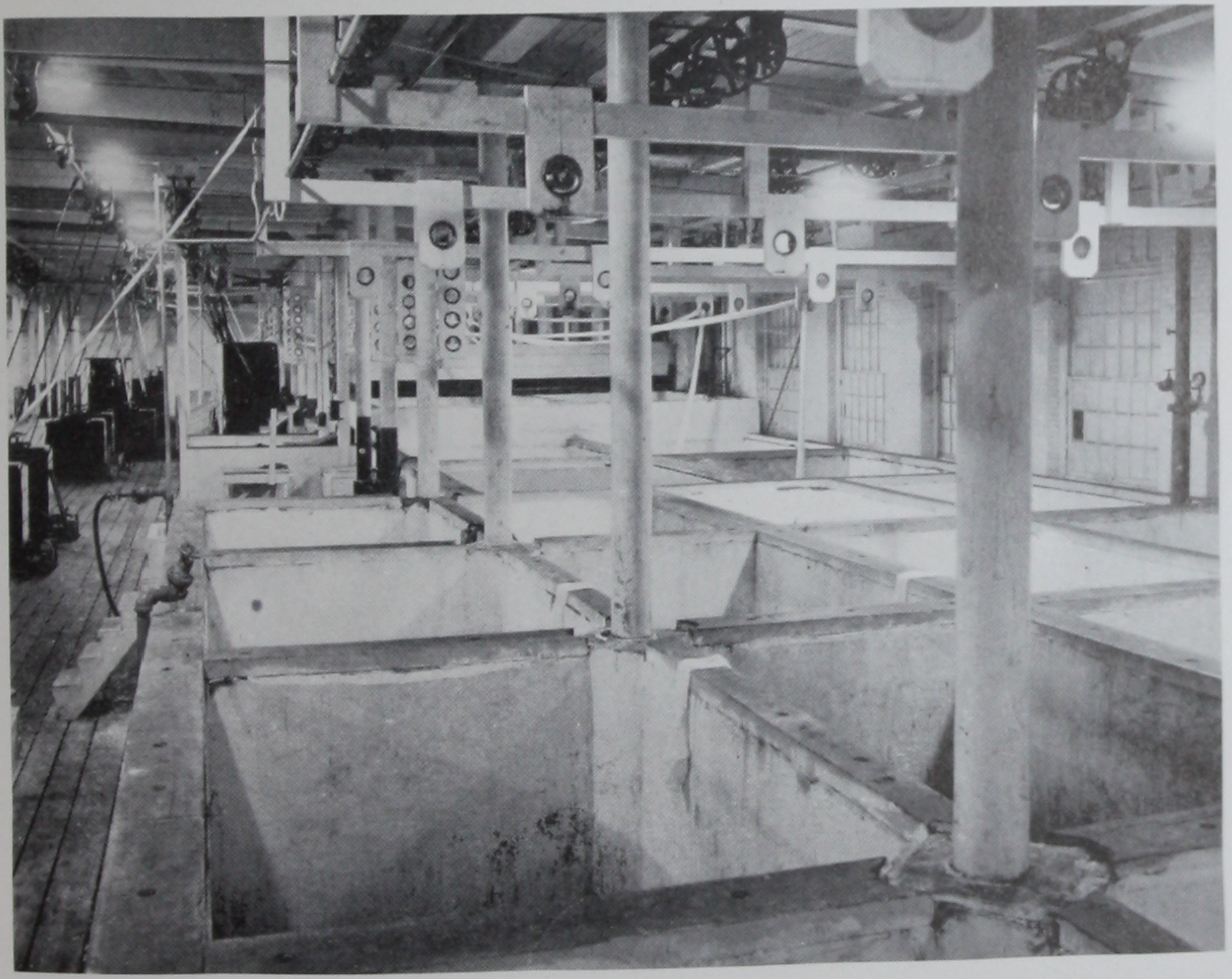

Fig. 21
Night View of Bleach House Lighted by 200-watt Bowl Enameled Mazda C Lamps in RLM Standard Dome Reflectors Equipped with Vapor-proof Globes. The intensity on the bins (3½ foot-candles) is adequate for the purpose. Certainly a higher quality of product can be produced in such a plant as this than in one where the only sources of light are a few low candle-power unshielded lamps at irregular intervals

Some plants are so laid out as to make this impracticable and localized lighting with angle reflectors must then be employed at the inspection points. These must be carefully placed so that they are not glaring to the operator at that or adjoining machines. All too frequently does one see bare lamps hanging between the inspector's eye and the fabric. Obviously his ability to see is materially reduced and severe fatigue is introduced.

*Yarding, Inspecting, Folding and Ticketing*

The lighting demands in this room are quite identical with those of the cloth room in the cotton mill. High intensity general illumination is essential.

*Laboratory and Color Room*

The dyer is well aware of the necessity for light of a constant and proper color quality. Light from the unobstructed north sky is generally desired for color matching. In some cases structural conditions are such as to make it impossible to secure this. Again it may be necessary to match after dark. Accurate type color identification units as described in Bulletin Index 3, "Artificial Daylight for Merchandising and Industry," are necessary in any efficient plant. These preferably should be so constructed that at

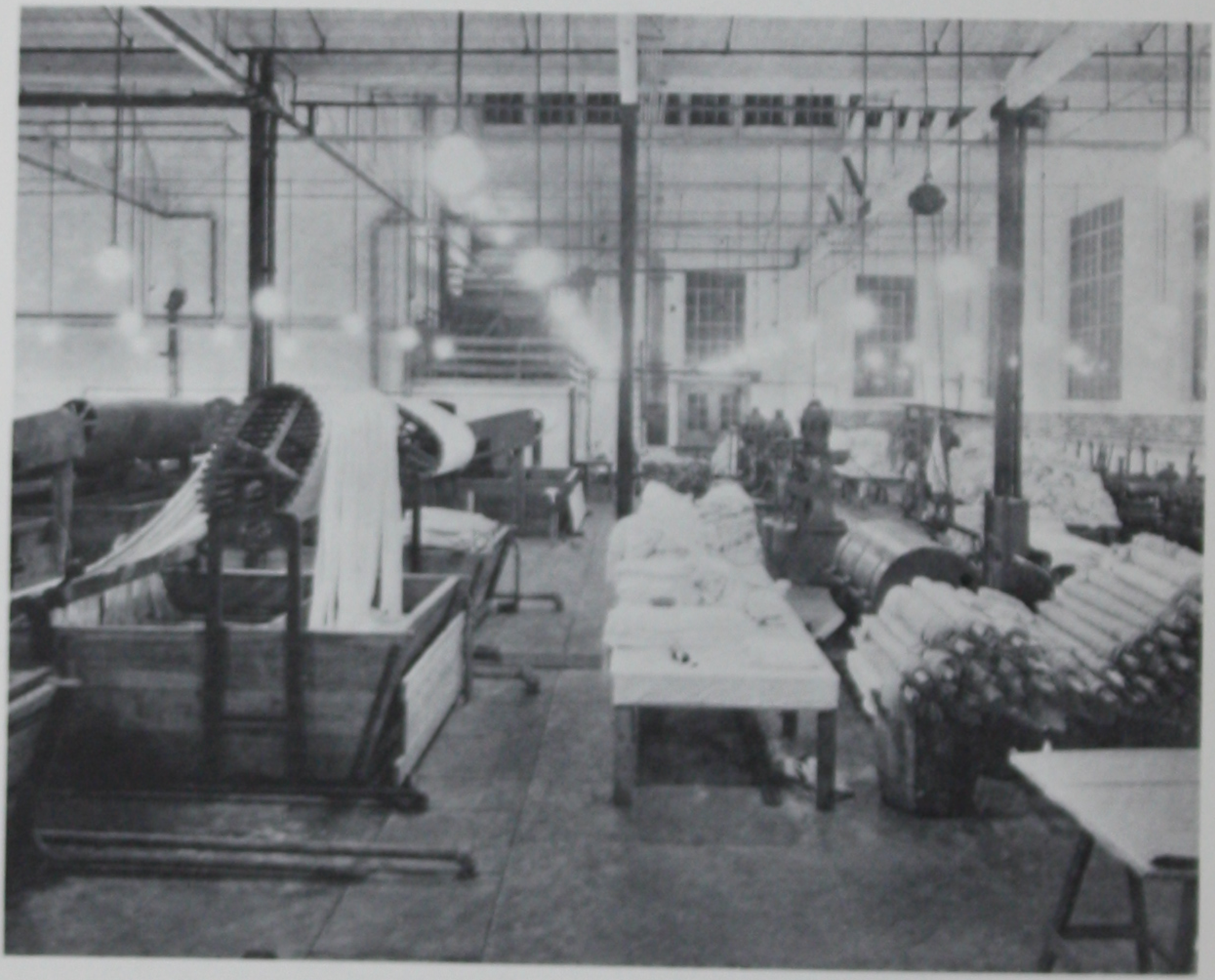

FIG. 22
Night View of a Dye House Lighted by 150-watt MAZDA C Lamps in Prismatic Glass Vapor-proof Reflector Globes. Outlets are on 10-ft. centers, lamps 10 feet high. Walls and ceilings are pure white. Average intensity of illumination in this plant, after the system had been in operation for three months, was over 10 foot-candles. It is indeed of interest to contrast such conditions as these with those too frequently encountered in industry

the turn of a switch, either north skylight or ordinary artificial light can be obtained. It is well to inspect the fabric under both conditions of lighting.

### *Conclusion*

All the methods suggested have been tried out and found satisfactory under actual operating conditions. The schemes suggested are not in any sense theoretical. If they are applied with discretion, there need be no hesitancy as to the light proving suitable for the work in hand.

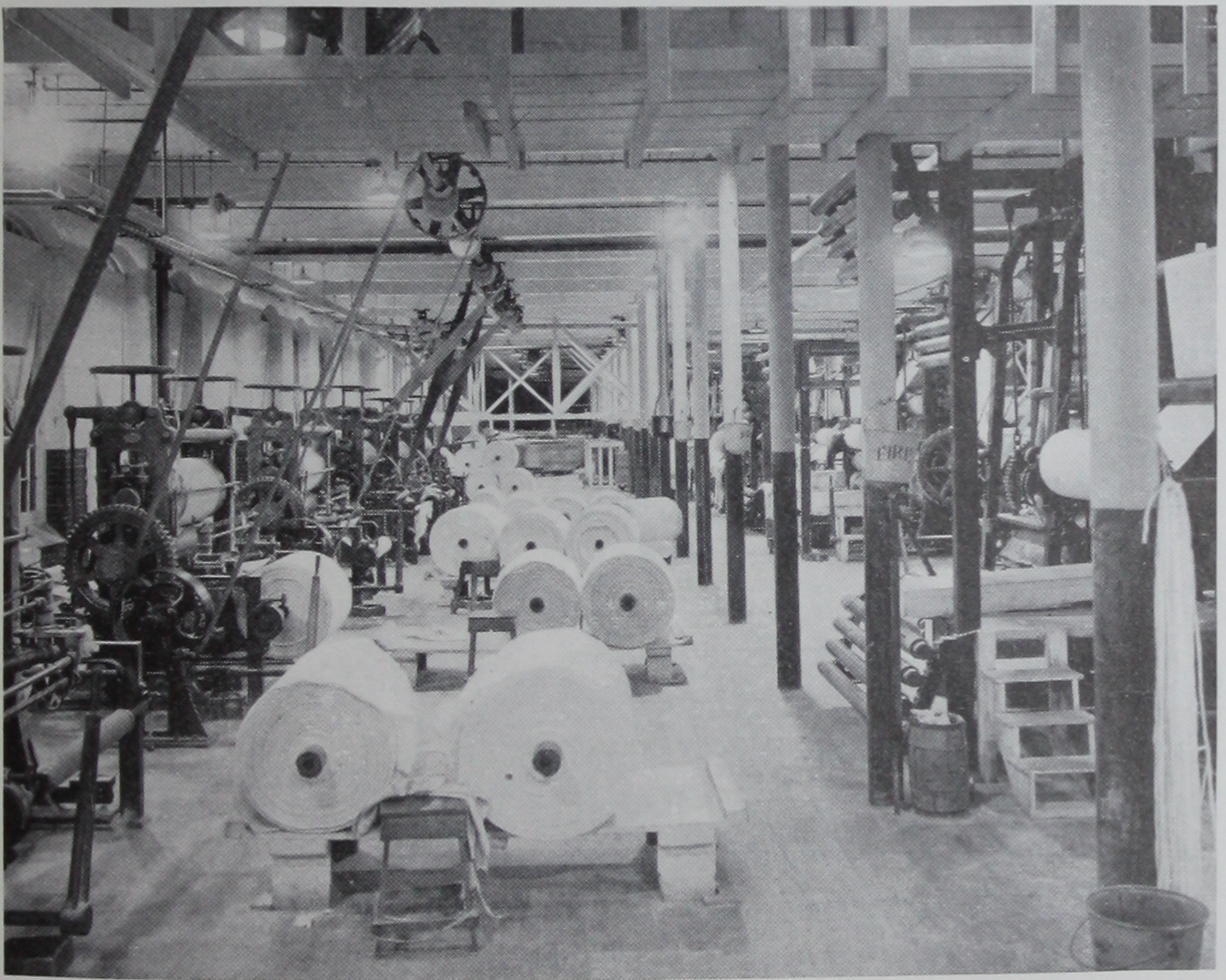

Fig. 23

The Vertical Surfaces on the Calenders are the Planes of Illumination in Such a Room as This. With well diffused general illumination as evidenced by this night photograph, all the machinery and product can be readily seen. Four foot-candles on both the horizontal and vertical planes is sufficient where white material alone is handled

It is very desirable that the ceiling and walls be light in color to reflect such light flux as strikes them. Much interesting data on the methods of painting will be found in Bulletin Index 15, "Effect of Color of Walls and Ceilings on Resultant Illumination."

Whatever system of lighting is used, the question of proper maintenance or cleaning of equipment is so important in obtaining satisfactory results that it has seemed desirable to treat this phase of lighting practice in a separate Bulletin Index 14. Every mill should have an organized system of maintaining lighting equipment.

The electric supply for the mill should be of such a capacity that voltage fluctuations are not introduced as the current demands change. A fluctuating or flickering light is very trying on the eye. The voltage should be maintained at a constant value, for lamps burned under voltage emit but a fraction of their normal output. 110 volts is far preferable to 220 volts for lighting circuits. Even when the latter is installed it is economy to modify the wiring so that the lower voltage is available. This subject is discussed in greater detail in Bulletin Index 4, "110 Versus 220 Volts for Lighting Service."

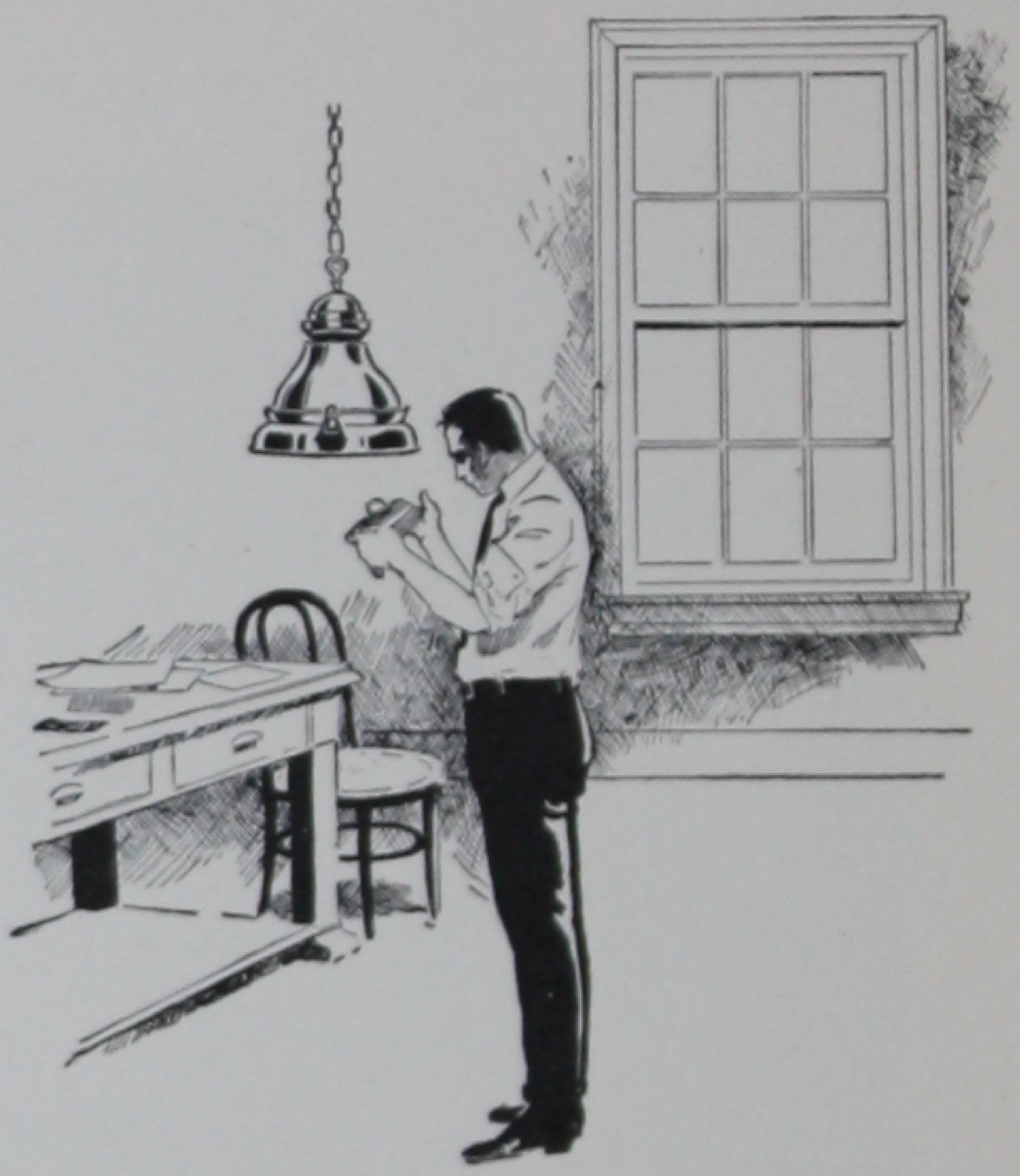

Fig. 24
A Color Identification Unit in use in the Dye House

In designing the lighting system for a textile mill, the following general rules must be kept in mind:

1. There must be sufficient light of the proper quality on the work.

2. Glare due to brilliant light sources or reflected from polished surfaces must be avoided in order that the operators may see to perform their work without eyestrain.

3. Diffusion and proper direction of light are necessary to eliminate sharp shadows. A moderate amount of illumination on the side walls helps in this connection and also makes the room more cheerful. On the other hand, it is tiring on the eye to continually face a very bright wall or window. Machines should be so placed that the operators are not forced to do this.

4. Besides having the work well lighted, a moderate intensity must be provided on intermediate sections, aisles, and the like, to prevent severe contrasts.

5. Any system installed in the mill should be simple in arrangement, reliable in operation and as low in operating cost as is compatible with good illumination. A minimum number of sizes of lamps should be standardized to prevent the carrying of excessive stocks and insure correct replacements.

In no case, however, should good lighting be sacrificed for slight savings in the cost of wiring or equipment, for in the long run, this will be found to be poor economy.

## *The Foot-Candle Meter*

The mill superintendent must know the lighting requirements of his mill, must equip it to meet these and then maintain the lighting devices as carefully as he does the machinery. This makes necessary an instrument with which he can readily measure the illumination and be certain that it is of sufficient intensity and proper distribution for economic production of cloth.

The Foot-candle Meter is such an instrument. It tells one the actual illumination at the work. Without one, the superintendent cannot know whether productive intensities are being maintained or even that he is conforming to State lighting codes.

If operators complain of inadequate illumination, the Foot-Candle Meter enables one to check the "light on the work." In connection with trial or experimental installations, or in planning the layout for new buildings or changed arrangements of machinery, it is invaluable.

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